

Air Quality Monitoring:

In the Fort Saskatchewan and Redwater Area

2006 and 2007

Final Report

Overview

In support of the existing monitoring in Fort Saskatchewan/Redwater area, Alberta Environment, in discussion with Fort Air Partnership, selected eleven monitoring sites near existing and planned industrial facilities for special air quality monitoring. A suite of inorganic and organic pollutants were monitored. For the time of study, concentrations measured did not exceed existing Ambient Air Quality Objective.

- Hydrocarbons were largely composed of methane and concentrations measured during the current study were comparable to background levels measured in Alberta (~2 ppm).
- Carbon monoxide concentrations were similar to observations measured during other Mobile Air quality Monitoring Laboratory (MAML) surveys. The higher concentrations were measured during meteorological conditions that suppressed dispersion of pollutants. The maximum one hour average concentration was 8% of Alberta's Ambient Air Quality Objective (AAAQO).
- A notable fraction of the one hour average total reduced sulphur and hydrogen sulphide concentrations were below detection limit. Detectable concentrations did not exceed the one-hour air quality objective. The maximum one-hour average H₂S concentration was 20% of AAAQO.
- One-hour average SO₂ concentrations were below Alberta's ambient air quality objective, the highest concentrations were measured near Shell Scotford and Oxyvinyls. The maximum one-hour average concentration was 15% of AAAQO.
- One-hour average, ammonia concentrations were also below the ambient air quality objectives. The maximum measured concentration of 0.953 was 48% of the AAAQO.
- The maximum one-hour average concentration for ozone was 76% of AAAQO. Proximity to Edmonton and/or roadways possibly affected concentrations measured.
- On average respirable particles concentrations (PM_{2.5}) formed 34% of PM₁₀. The maximum one-hour average concentrations at the various sites range from 14 to 128 µg/m³.
- The median one-hour polycyclic aromatic hydrocarbons (PAHs) concentrations at the various sites were below or close to instrument lower detection limit (3 ng/m³).
- Methanol, propane, butane and acetone were the four highest volatile organics compounds (VOCs) at most of the VOCs sites.

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1 Introduction

The city Fort Saskatchewan and town of Redwater are located northeast of the city of Edmonton. The Fort Saskatchewan-Redwater area has a number of industrial facilities and arterial roads. The area falls into Fort Air Partnership's (FAP) airshed, where FAP monitors air quality on an ongoing bases. In support of the existing monitoring in the area, Alberta Environment, in discussion with FAP, selected monitoring sites near existing and planned industrial facilities for special air quality monitoring.

Alberta Environment regularly conducts air quality surveys as part of its air quality monitoring program. For the current survey the department's Mobile Air Monitoring Laboratory (MAML) was used to monitor the air quality at the selected locations. Measurements performed by instruments onboard the MAML provide a "snap shot" of the air quality in time and space. The MAML is equipped to measure a suite of pollutants typically associated with industrial and urban emissions. In addition, air samples were collected using stainless steel canisters for laboratory analysis of volatile organic compounds (VOCs). These one-hour integrated samples were analyzed for 185 individual hydrocarbon compounds.

The current study in the Fort Saskatchewan and Redwater area was conducted as a follow up to a study conducted in 2001/2002. Five of the eleven sites for the current study were also part of the 2001/2002 study. The current air quality study started in December 2006 and ended in November 2007. Throughout the sample period a total of 114 hours of data were collected using the MAML and 7 samples were collected for VOCs analysis.

2 Monitoring method and location

Air quality surveys were conducted using the department's Mobile Air Monitoring Laboratory (MAML). The MAML is equipped to measure ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide simultaneously. A description of the MAML and the detection limit of the various instruments onboard are given in Appendix B.

Air samples for volatile organic compound (VOCs) analysis were collected using stainless steel canisters (SilcoSteel®). These canisters are under high vacuum and are fitted with flow regulators such that the sample gradually fills the vessel. For the current survey the canister sample period was one-hour and VOCs concentrations determined are an average for the sample period. Environment Canada's *Analysis and Air Quality Laboratory* in Ottawa carried out canister preparation and VOCs analyses. The canister samples were analyzed for up to 185 individual organic compounds.

Air quality surveys were designed to provide information on pollutant levels downwind of existing facilities as well as baseline concentrations in the area of planned facilities. The sample sites for the study are listed in Table 1 and their locations are indicated in Figure 1. Monitoring at each of the sites consisted of seven to twelve one-hour samples. Five of the sample sites (**Site 4, 5, 6, 18 and 20**) were near an industrial facility. The industries included petrochemical refineries, fertilizer, pesticide and organic chemical producers, and an oilseed mill. Two sites (**Sites 19 and 22**) were at future industrial sites. Data was collected at these two sites to measure baseline concentrations. There were two town centre sample sites: Redwater (**Site 7**) and Bruderheim (**Site 11**). **Site 21** was located near the Acclaim battery¹. **Site 17** was located between Edmonton and Fort Saskatchewan and was considered a boundary site.

¹ Oil/Gas transfer station where fluid from a well is measured and stored.

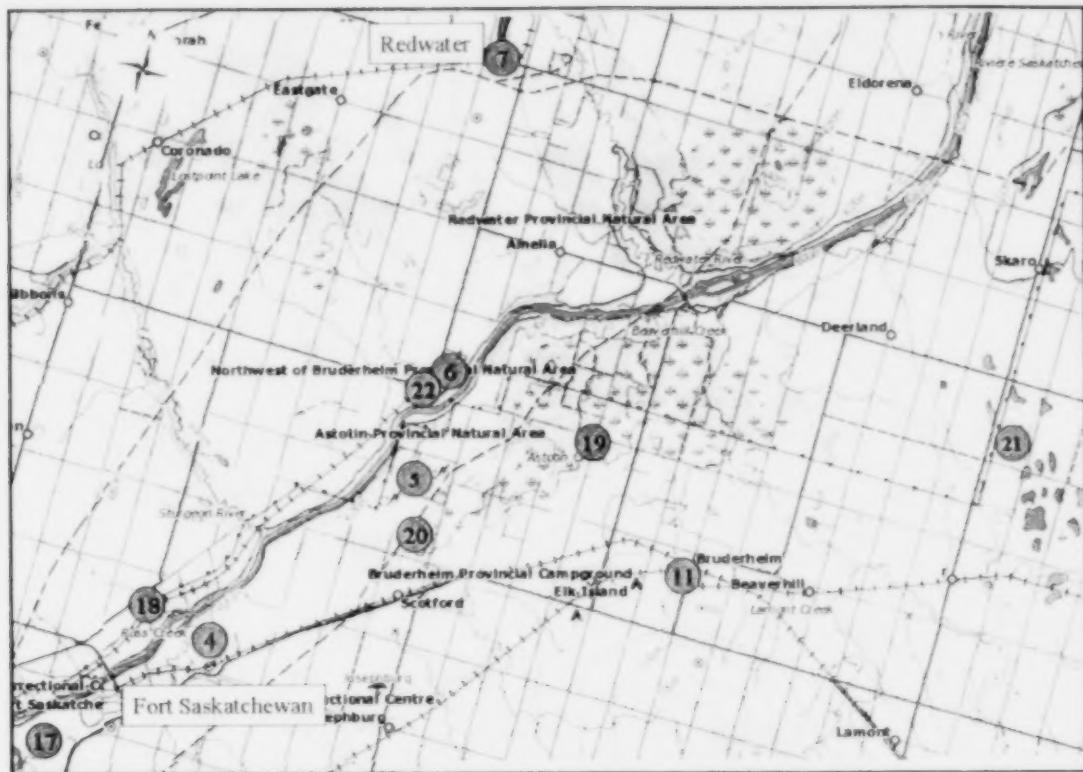


Figure 1: Map of monitoring locations. The base map is obtained from <http://atlas.nrcan.gc.ca/site/english/maps/topo/map>

Table 1: List of monitoring locations

Site	Site name	Description
4	Dow and Sheritt	Petrochemical refinery (Dow) and Pesticide and Fertilizer production (Sheritt)
5	Shell Scotford	Petrochemical refinery
6	Agrium Redwater	Fertilizer production
7	Redwater	Town centre
11	Bruderheim	Town centre
17	Dow Centennial ball fields	Boundary site
18	Canola oil plant/Bunge Canada	Grain and oilseed milling
19	BA Upgrader	Future site of
20	Oxyvinyls/Gulf Chemicals ²	Organic chemical manufacturing
21	Acclaim Battery	Battery site
22	NorthWest Upgrader	Future site of

² Oxyvinyls ceased operation in March of 2006. Gulf chemicals took over operations October 2006.

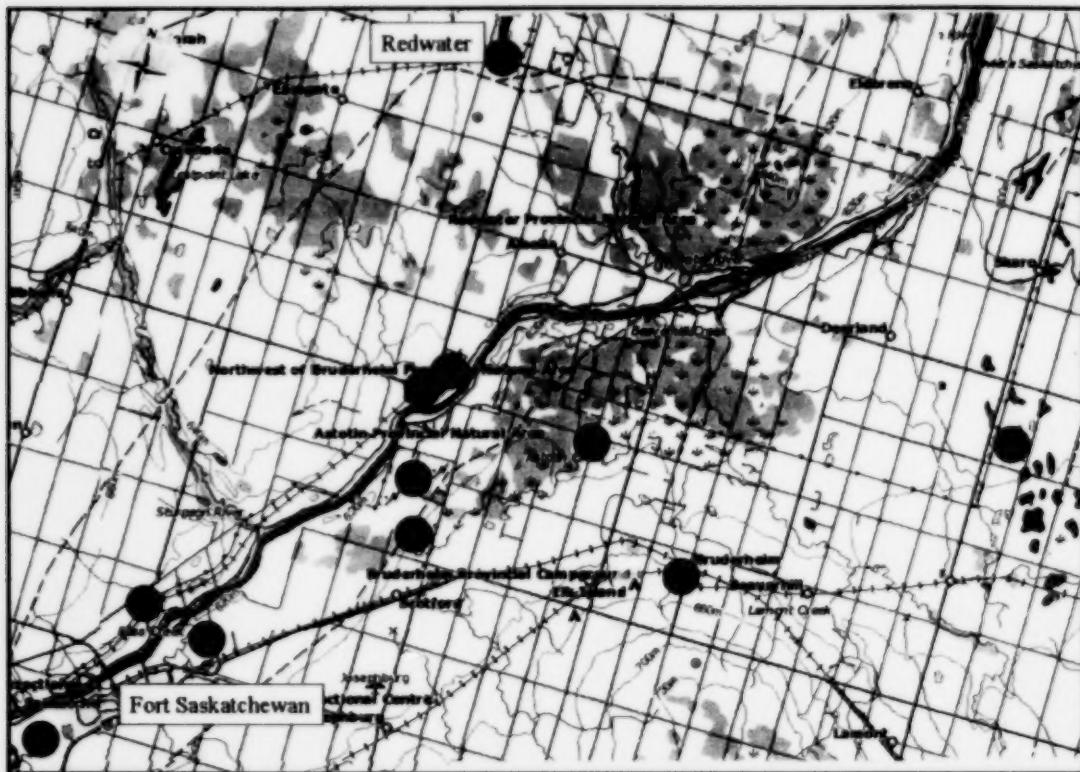


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19	BA Upgrader	<i>Future site of</i>
20	Oxyvinyls/Gulf Chemicals ²	Organic chemical manufacturing
21	Acclaim Battery	Battery site
22	NorthWest Upgrader	<i>Future site of</i>

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3 Results and Discussion

Several one-hour samples were collected at each of the eleven sample sites. In discussing the results, the median and the maximum one-hour average concentrations are presented. These concentrations are compared to established **Alberta Ambient Air Quality Objectives** (AAAQO). The median concentration is a common way of representing the central value for environmental data. Further justification for using the median concentration and information on AAAQO are presented in Appendix B.

The concentration of certain pollutants that Alberta Environment monitors can be below the lower detection limit of the instruments onboard the MAML. A dataset may contain a large number of concentrations below the detection limit and a few concentrations within the operating range of the MAML instruments. In such cases, it is possible to have a median one-hour average concentration that is 'undetectable' or below the lower detection limit (*bd*) while still having a 'detectable' maximum one-hour average concentration. *The key in Figure 2 illustrates how the median and maximum one-hour average concentrations are represented in the following section.*

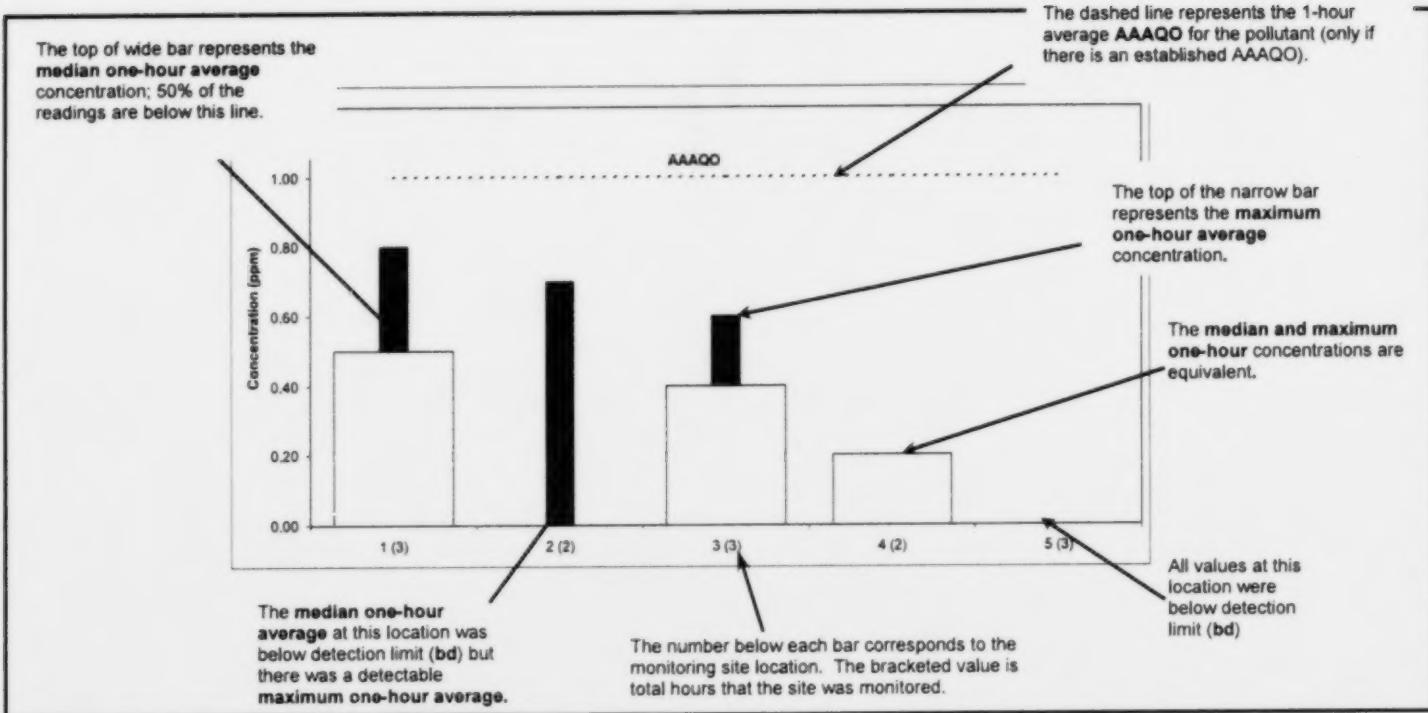


Figure 2: A key for interpreting the figures in the following section.

3.1 Hydrocarbons

The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms. Methane (CH_4), is the most common hydrocarbon in the earth's atmosphere. As a result, for most measurements around Alberta, concentrations of THC and CH_4 are equivalent and a background concentration of about 2 ppm is typically measured. Reactive hydrocarbons (RHC) form the remaining fraction of THC. RHC are important because: (1) they can react with oxides of nitrogen in the presence of sunlight to form ozone; and (2) some RHC can be toxic (at high concentrations) to humans, animals or vegetation. The major sources of hydrocarbons include vegetation, vehicle emissions, gasoline storage tanks, petroleum and chemical industries and fugitive emissions such as leaks and evaporation of solvents.

Concentration of THC, CH_4 and RHC are presented in Figures 3 to 5. The y-axis of these figures have the same range to facilitate comparison. Eighty-nine percent of the one-hour average CH_4 concentrations were equivalent to that of THC. The *median* one-hour average concentration for both CH_4 and THC ranged from 1.9 to 2.2 ppm. The maximum one-hour concentrations measured at the various stations ranged from 2.1 to 3.1 ppm for THC, and 2.1 to 3.0 ppm for CH_4 . These observations indicate that on average hydrocarbon concentrations largely consisted of CH_4 , and with the exception of few samples, concentrations measured were comparable to background levels. Table A1 in the appendix illustrates that the median one-hour average THC for this study was among the lowest measured for recent MAML studies. One-hour average reactive hydrocarbon concentrations were largely below the detection limit (0.1 ppm). The maximum one-hour concentrations ranged from below detection limit to 0.4 ppm (measured at Site 4: Dow and Sheritt). The maximum one-hour average THC concentrations during 2000/2001 study ranged from 2.3 to 3.6 ppm. The maximum one-hour RHC concentrations ranged from 0.1 to 0.5 ppm.

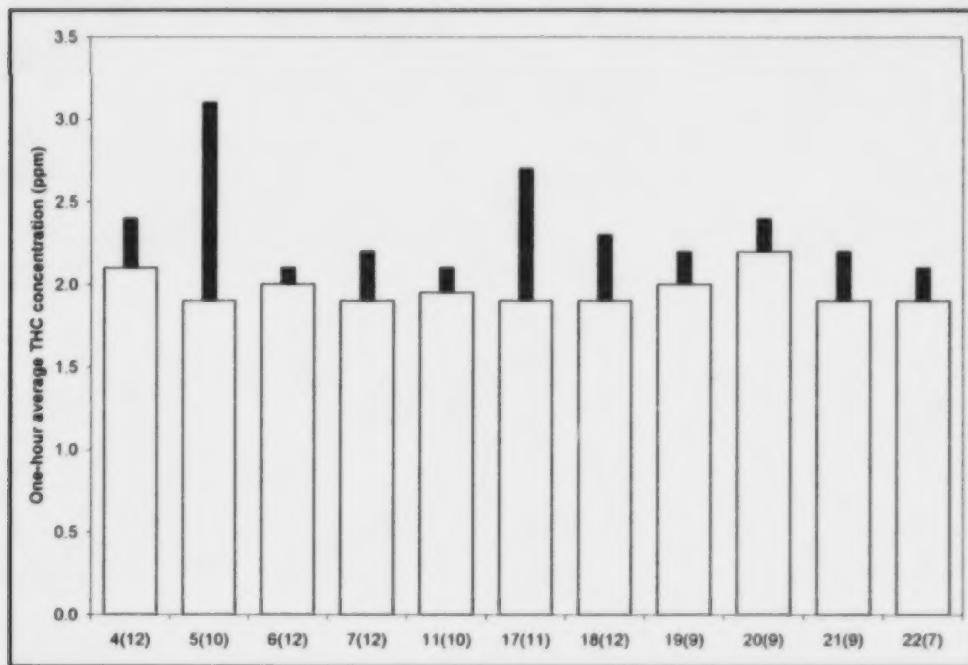


Figure 3: Median and maximum one-hour average concentrations for total hydrocarbons.

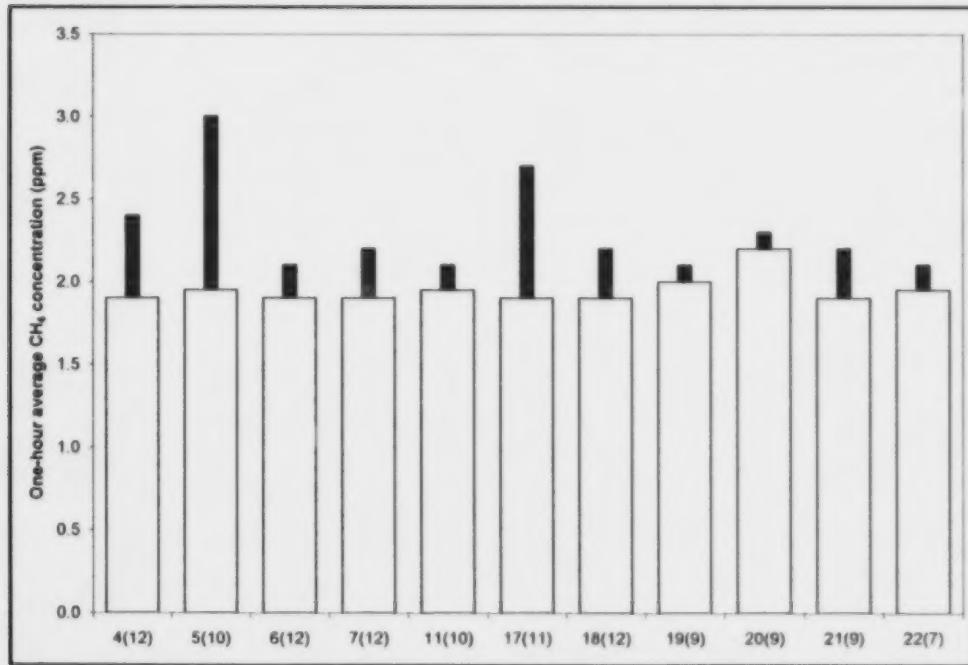


Figure 4: Median and maximum one-hour average concentrations for methane.

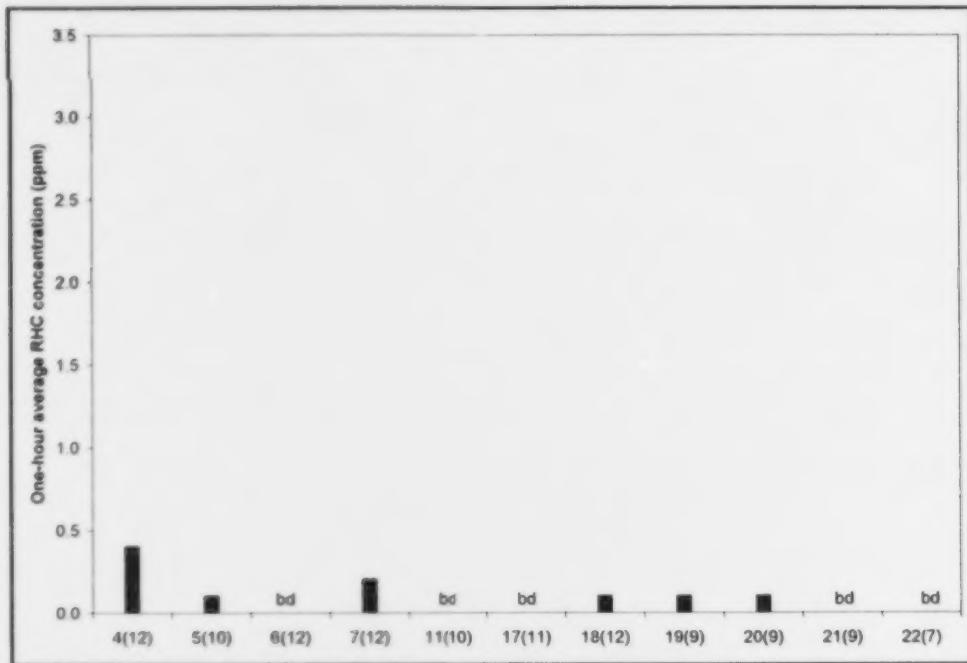


Figure 5: Median and maximum one-hour average concentrations for reactive hydrocarbons.

Note:

bd - indicates the concentration is below the detection limit of the instrument on board the MAML.

3.2 Carbon Monoxide

Incomplete combustion produces carbon monoxide (CO). Motor vehicles are the primary source of CO, although emission from industrial activities and fires can also contribute. Alberta has a one-hour air quality objective of 13 ppm for CO. Figure 6 illustrates the median and maximum one-hour averages at the various monitoring sites. Concentrations measured were notably lower than the air quality objective. The median one-hour average did not significantly vary between monitoring sites ranging from 0.2 to 0.3 ppm. These values are similar to concentrations measured at most other MAML surveys as well as air quality monitoring stations (Table A1). The maximum one-hour average concentrations ranged from 0.4 to 1.1 ppm. CO concentrations greater than 0.7 ppm were observed during calm conditions (≤ 3 km/hr), which likely reduced the dispersion of pollutants.

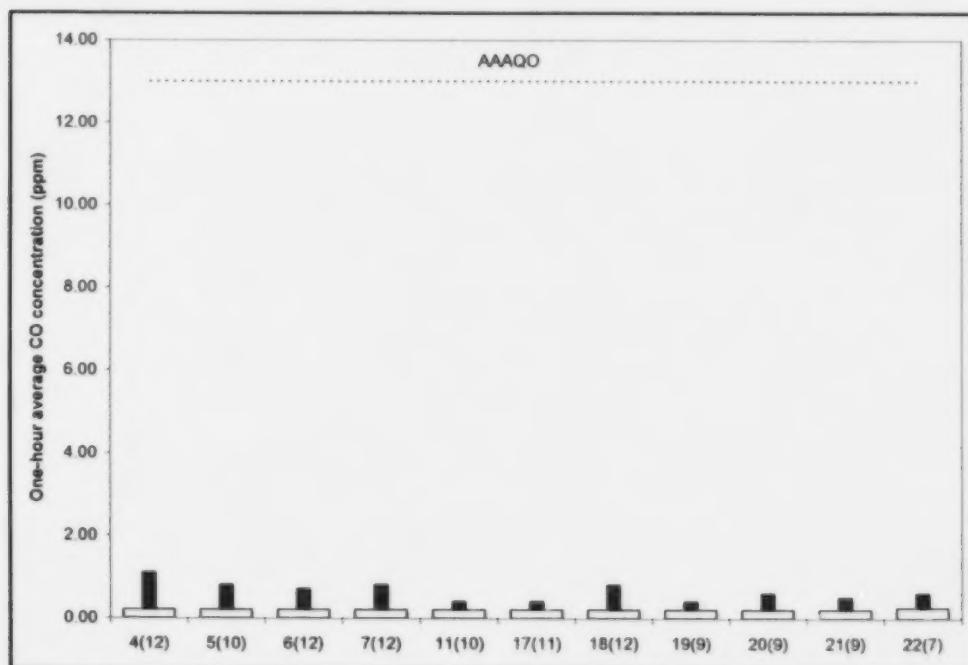


Figure 6: Median and maximum one-hour average concentrations for carbon monoxide.

3.3 Total Reduced Sulphur (TRS) Including Hydrogen Sulphide (H₂S)

Total reduced sulphur (TRS) includes hydrogen sulphide (H₂S), mercaptans, dimethyl sulphide, dimethyl disulphide, and other sulphur compounds. Sulphur dioxide is not a reduced sulphur; this pollutant will be discussed in a separate section. The major industrial sources of H₂S and TRS are petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants that use the Kraft pulping process, and animal feedlots. Natural sources of H₂S include sulphur hot springs, sloughs, swamps and lakes.

For most MAML surveys, H₂S forms a major component of the total reduced sulphur compounds. The median and maximum one-hour averages for H₂S and TRS are presented in Figures 7 and 8. To facilitate comparison, the y-axis of these figures have the same range. Sixty-three percent of the one-hour average TRS concentrations were below the lower detection limit of the instrument on board the MAML. The maximum one-hour average concentration measured at the various stations ranged from 0.001 to 0.005 ppm. Similarly one-hour average H₂S concentrations were also low and well below the one-hour air quality objective of 0.010 ppm. The one-hour maximum concentrations for H₂S ranged from below detection to 0.002 ppm. These findings were very similar to concentrations measured during the 2001/02 study.

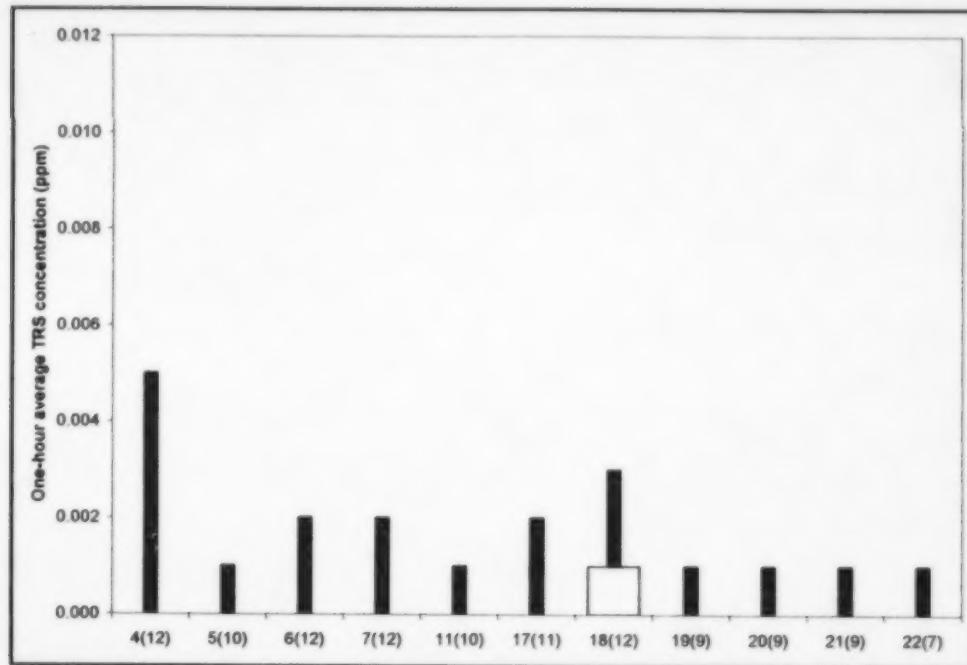


Figure 7: Median and maximum one-hour average concentrations for total reduced sulphur.

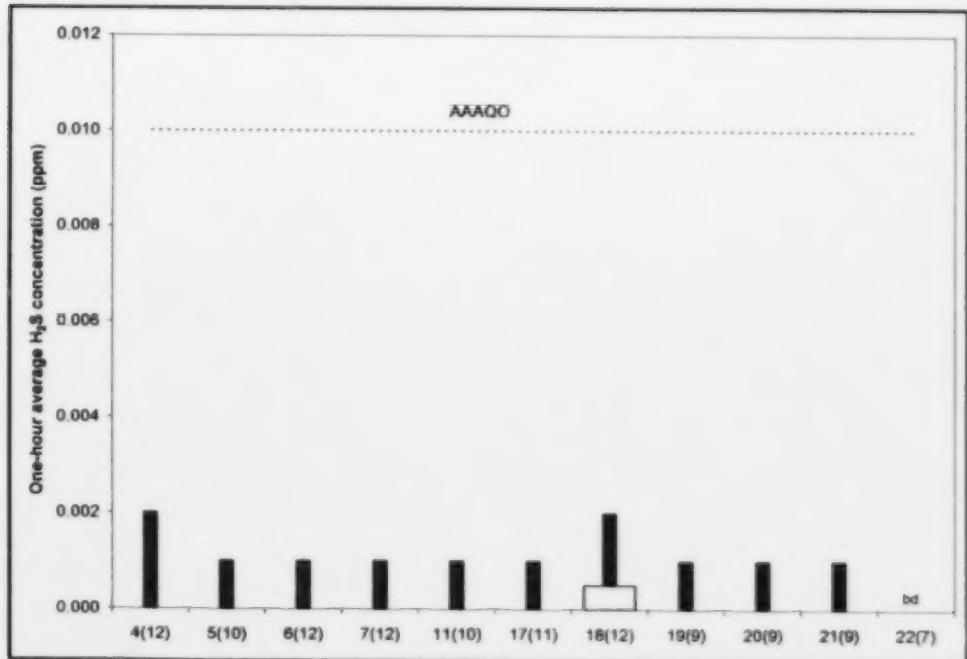


Figure 8: Median and maximum one hour average concentrations for hydrogen sulphide.

3.4 Sulphur Dioxide (SO₂)

In Alberta, upstream oil and gas processes are responsible for close to half of the SO₂ emissions in the province. Oil sands facilities and power plants are also major SO₂ sources. Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

One-hour average SO₂ concentrations measured during this study were notably lower than the ambient air quality objective of 0.172 ppm. The *median* one-hour average concentration did not vary significantly at the various sites, ranging from 0.002 to 0.005 ppm. These concentrations are comparable to concentrations measured during other MAML surveys (Table A1). The *maximum* one-hour average concentrations measured at **Sites 5 and 20** (Shell Scotford and Oxyvinyls/Gulf Chemical) were the two most elevated concentrations (0.025 and 0.021 ppm, respectively).

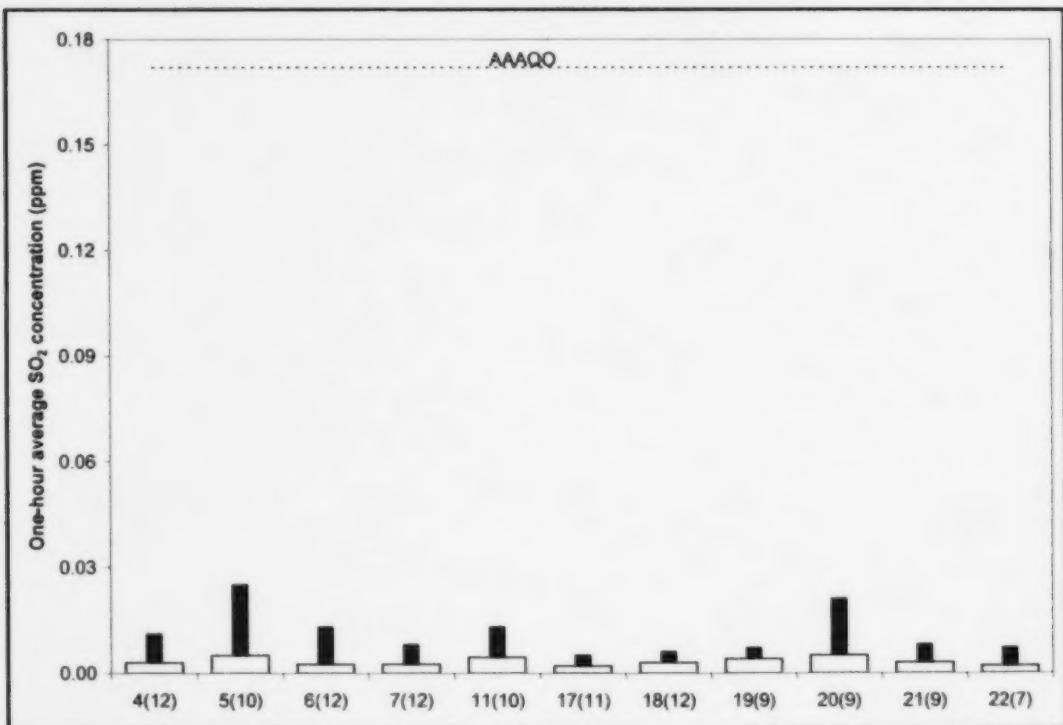


Figure 9: Median and maximum one-hour average concentrations for sulphur dioxide.

3.5 Ammonia (NH₃)

NH₃ is produced both by natural and man-made sources. Some natural sources of NH₃ include the decay of plant material and animal waste. In Alberta, the fertilizer industry is the main industrial source of NH₃. The other major source of NH₃ is commercial feedlots, specifically from their large amounts of decaying animal wastes. Alberta has an ambient air quality objective for NH₃ of 2.0 ppm.

As illustrated in Figure 9, one-hour average concentrations measured during this study were lower than Alberta's air quality objective. The maximum one-hour average concentration of 0.953 ppm was measured at Site 4 (Dow and Sheritt). The highest one-hour average concentration during the 2001/2002 study of 0.557 ppm was also measured at Site 4. For the current study, elevated NH₃ concentrations were observed for sample periods when the MAML was downwind of Sheritt International. It is likely that NH₃ concentrations at this site were influenced by industrial emissions, such as those from inorganic chemical production. The median one-hour concentration at the various sites in this study ranged from below detection limit to 0.009 ppm. It is important to note that the median NH₃ concentration at Site 4 was 0.008 ppm; this value is comparable to the median concentrations measured at a number of other sites. Furthermore, NH₃ concentration measured during the current survey was among the lowest measured during recent MAML surveys (Table A1).

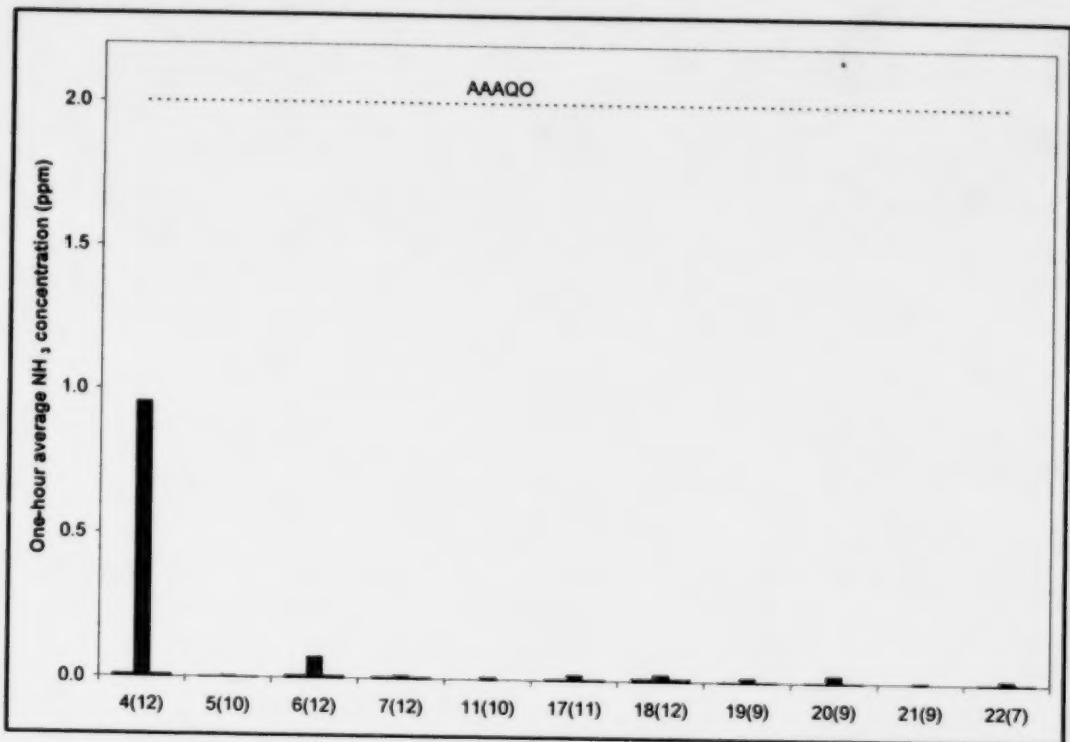


Figure 10: Median and maximum one-hour average concentration for ammonia.

3.6 Oxides of Nitrogen (NO, NO₂ and NO_x)

Nitrogen dioxide (NO₂) and nitric oxide (NO) are known as oxides of nitrogen (NO_x). In Alberta, transportation (automobiles, locomotives and aircraft) is the major source of NO_x. NO_x and volatile organic compounds play a major role in the formation of ground level ozone. NO₂ is a reddish-brown gas and is partially responsible for the "brown haze" observed near large cities. Other major sources include the oil and gas industries and power plants. Alberta has a one-hour ambient air quality objective for NO₂ of 0.212 ppb. Although both NO and NO₂ may be emitted by high temperature combustion processes. Typically the latter forms the significant fraction³. Often the ratio of NO and NO₂ is used to determine the relative age of air mass. This is because NO is readily converted in the atmosphere into NO₂ through reaction with O₃.

Figure 10 and 11 illustrate the median and maximum NO₂ and NO concentration measured at the various monitoring locations. One-hour average NO₂ concentrations were all below the AAAQO. The maximum one-hour average NO₂ concentration ranged from 0.046 ppm (Site 4: Dow and Sheritt) to 0.019 ppm (Site 22: future site of NW upgrader). A majority of the one-hour average concentration was notably lower than the maximum observed. The median one-hour average NO₂ concentrations for example ranged from 0.002 ppm to 0.009 ppm. These median values are comparable to concentrations measured at other MAML surveys conducted away from transportation sources and at rural air quality monitoring stations (Table A1).

On average, NO formed 43% of the one-hour average NO_x measured at the various stations. However during periods of elevated concentrations NO formed close to 70% of NO_x suggesting relatively fresh emission. Elevated one-hour average NO concentrations of 0.105 and 0.100 ppm were measured at Site 4. The one-hour average NO concentration of 0.105 ppm was measured during a winter sample (Feb 9, 2006) and elevated concentrations were measured concurrent with elevated ammonia (NH₃). NO concentration at this time possibly had an industrial source. One-hour average of 0.100 ppm was measured at the same time as elevated particulate matter and PAHs, implying a combustion source⁴.

³ Slotiv P., and Weilenmann M.(2003). NO₂/NO emission of gasoline passenger cars and light-duty trucks with Euro-2 emission standard. *Atmospheric Environment* 37, pp5207-5216.

⁴ See Section 3.8

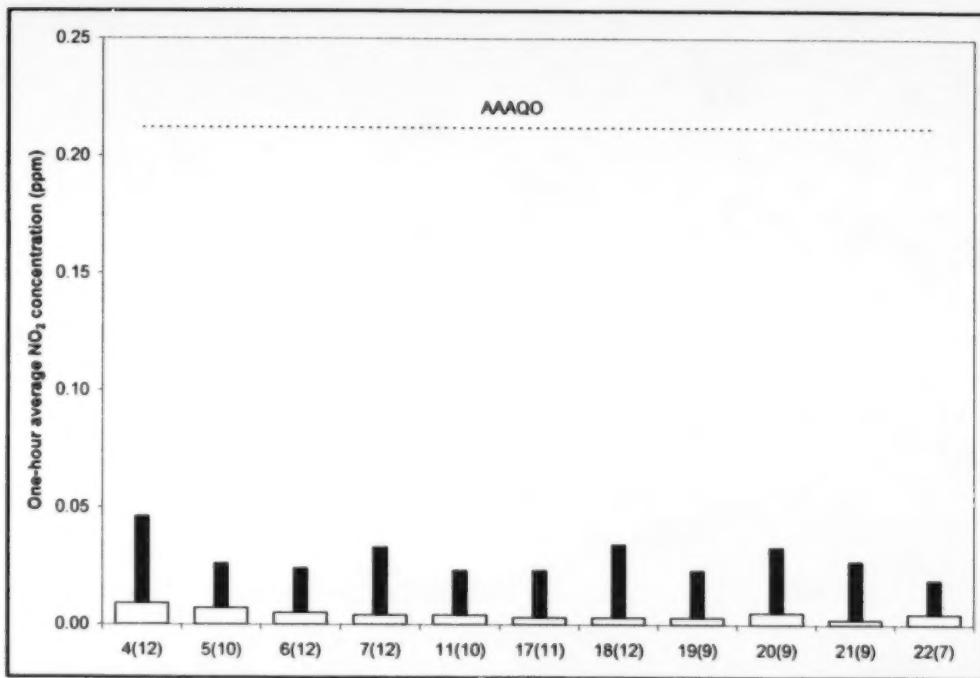


Figure 11: Median and maximum one-hour average concentrations for nitrogen dioxide.

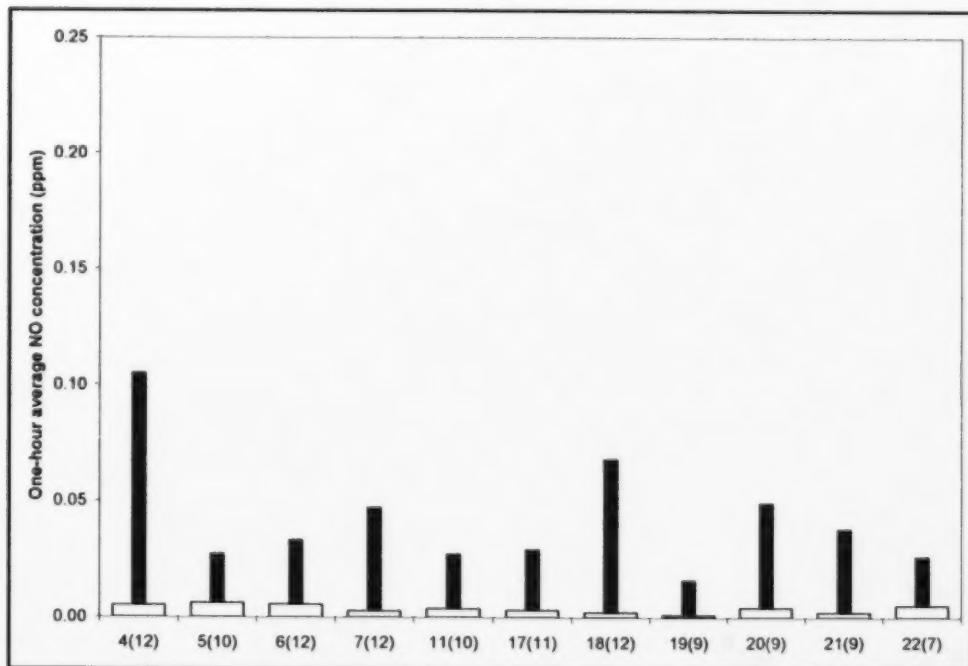


Figure 12: Median and maximum one-hour average concentrations for nitric oxide.

3.7 Ozone (O_3)

Ozone (O_3) is not emitted directly by human activities. In the lower atmosphere it is formed through chemical reactions involving nitrogen dioxide (NO_2) and volatile organic compounds (VOCs) in the presence of sunlight. O_3 is a major component of smog. O_3 concentrations are generally lower at urban locations. This is due to the destruction of O_3 by vehicle-emitted nitric oxide (NO). Ozone levels are typically higher during the spring and summer months when solar radiation is readily available. Alberta has a one-hour air quality objective of 0.082 ppm for O_3 .

Figure 12 illustrates the median and maximum one-hour average for O_3 . The one-hour average concentrations at the various stations did not exceed AAAQO for O_3 . The maximum one-hour averages ranged from 0.047 to 0.062 ppm. Elevated one-hour average concentrations were measured for spring sample periods (April and May). This is in agreement with data collected at the Fort Saskatchewan air quality monitoring station⁵.

The median one-hour average concentrations measured during this study ranged for 0.020 to 0.039 ppm. The lower range concentration is comparable to concentrations measured in urban areas (Table A1). The highest median 0.039 ppm was determined for Site 7 (Redwater). Proximity to Edmonton and or major road ways possibly affected ozone concentrations measured at these sites.

⁵ Monthly average ozone concentration collected between 2000-2007 indicated that the maximum ozone concentration is typically observed in April and May.

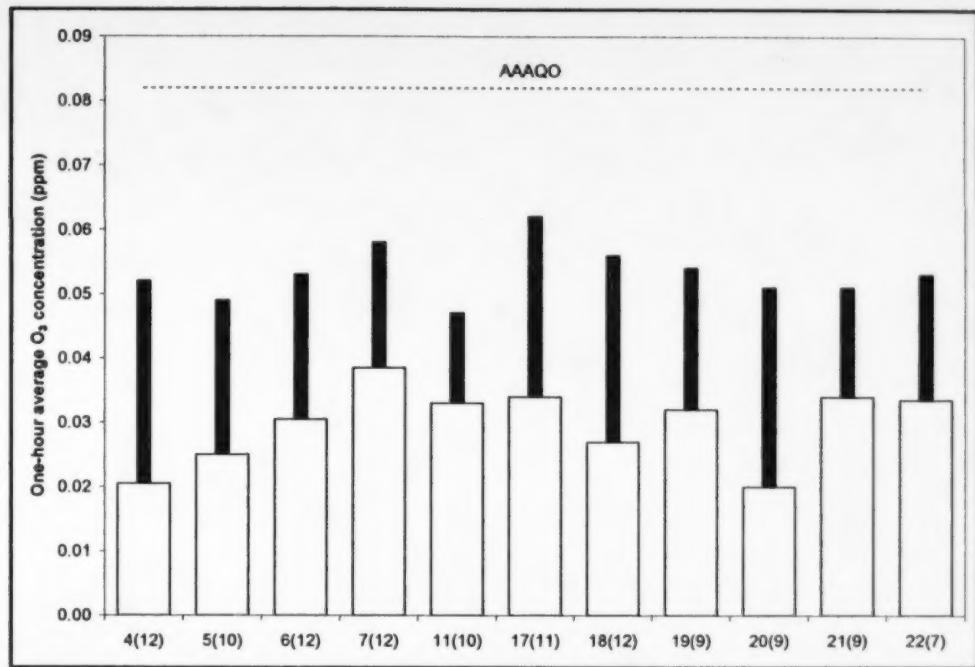


Figure 13: Median and maximum one-hour average concentrations for ozone.

3.8 Particulate Matter (PM₁₀ and PM_{2.5})

Inhalable particulates are particulate matter less than 10 micrometres (μm) in aerodynamic diameter (PM₁₀). These particles can be inhaled into the nose and throat. Sources of PM₁₀ include soil dust, road dust, agricultural dust (e.g., harvest), smoke from forest fires and wood burning, vehicle exhaust and industrial emissions. Respirable particulates are those particulate matter less than 2.5 μm (PM_{2.5}) in aerodynamic diameter. These particles are small enough to penetrate into the lungs. Respirable particulates may form in the atmosphere and/or arise from combustion sources such as vehicle exhaust emissions, industrial emissions and wood burning. In addition to PM₁₀ and PM_{2.5}, total suspended particles (TSP) and PM₁ (particles less than 1 μm in aerodynamic diameter) were also measured for a portion of the study. TSP range in size from 0.001 to 500 μm ; this group includes PM₁₀, PM_{2.5} and PM₁. Although not included in the discussion concentrations of TSP and PM₁ are included in Table A2.

To facilitate comparison, the y-axis of Figure 14 and 15 are equivalent. Alberta has a one-hour ambient guideline⁶ for PM_{2.5} of 80 $\mu\text{g}/\text{m}^3$. One-hour average PM_{2.5} concentrations during this study did not exceed this level. The median one-hour PM_{2.5} concentrations did not significantly vary between sites ranging from 2 to 4 $\mu\text{g}/\text{m}^3$. The maximum one-hour concentrations ranged from 5 to 16 $\mu\text{g}/\text{m}^3$. PM_{2.5} formed on average 34% of the PM₁₀ mass concentration. This being said there were a number of sample hours (16 of 114 samples) when respirable particles (PM_{2.5}) composed greater than 70% of PM₁₀. This observation typically occurred for low to moderate PM₁₀ concentrations (less than 15 $\mu\text{g}/\text{m}^3$).

As illustrated in Figure 15, maximum PM₁₀ concentrations were notably higher than median values. The median one-hour average PM₁₀ concentrations ranged from 7 to 18 $\mu\text{g}/\text{m}^3$. The maximum one-hour average concentrations ranged from 14 to 128 $\mu\text{g}/\text{m}^3$. A maximum one-hour average concentration of 106 and 128 $\mu\text{g}/\text{m}^3$ were measured at **Site 17** (Dow Centennial ball field) and **4** (Dow and Sheritt), respectively. The elevated concentration at **Site 4** was observed concurrent with elevated NO at this time PM_{2.5} composed only 13% of PM₁₀ concentration. The maximum one-hour average PM₁₀ at Dow Centennial ball field (**Site 17**), was associated with elevated NH₃ for the site. Similarly for this sample PM_{2.5} percentage of PM₁₀ was low at 9%. The low PM_{2.5} concentration relative to PM₁₀ implies notable contribution from coarse particles.

⁶ This guideline is for the purpose air quality evaluation only and should not be used for compliance purposes.

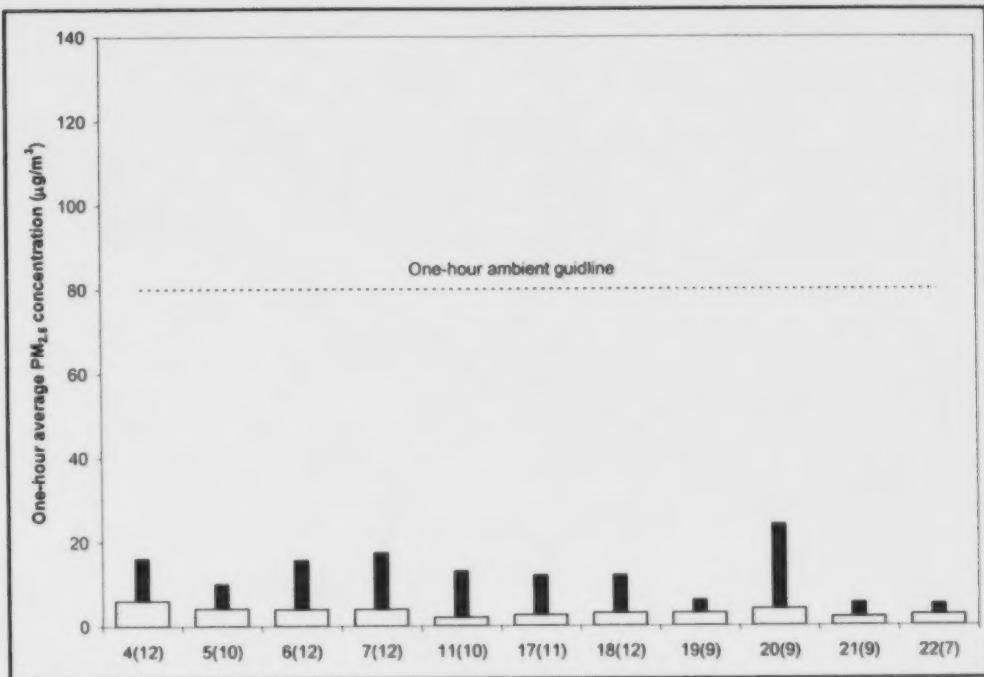


Figure 14: Median and maximum one-hour average concentrations for PM_{2.5}.

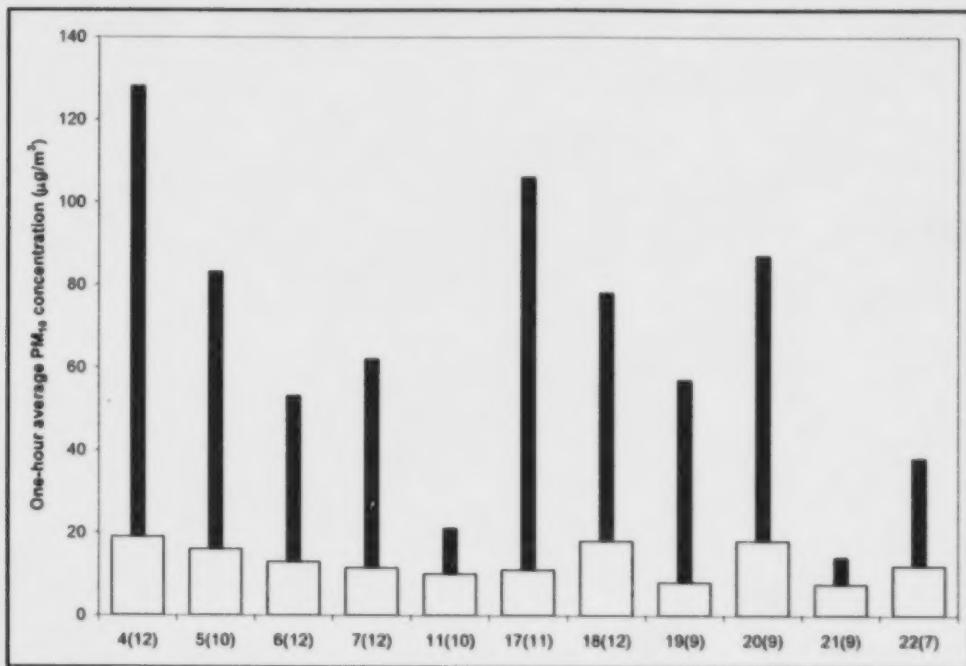


Figure 15: Median and maximum one-hour average concentrations for PM₁₀.

3.9 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons are organic compound consisting of two or more benzene rings and are formed through incomplete combustion. Ambient sources of PAHs include vehicle exhaust, wood smoke from residential and industrial use and forest fires. PAHs occur as complex mixtures and can be found as a gas or condensed onto particles. The phase of PAHs is dependant on ambient conditions such as temperature and the molecular structure of the compound. Larger PAHs (containing more benzene rings) tend to be found in the condensed phase (bound onto particles). It is these types of PAHs that are measured by the MAML. There are more than 100 different PAHs with varying levels of toxicity.

PAHs measured during previous MAML surveys usually have concentrations below the detection limit of the instrument on board (3 ng/m³). The exceptions are the Slave Lake and Calder Yard studies. Samples from the Calder Yard study were strongly influenced by emission from vehicles on the Yellowhead Highway, resulting in elevated PAHs concentration. The median one-hour average concentrations for recent MAML surveys are presented in Table A1.

For the current survey the *median* one-hour average concentrations were below or close to the minimum detection limit of the instrument used. However, at *most* monitoring sites PAHs concentration greater than 10 ng/m³ was measured for at least one sample hour. Elevated concentrations were typically noted at the same time as above median NO_x and particulate concentrations. The maximum one-hour average PAHs concentration ranged from 5 ng/m³ (measured at Site 22) to 29 ng/m³ (measured at Site 20). Site 20 (Oxyvinyl/Gulf chemicals) had the most one-hour PAHs concentration above 10 ng/m³ (Table A2).

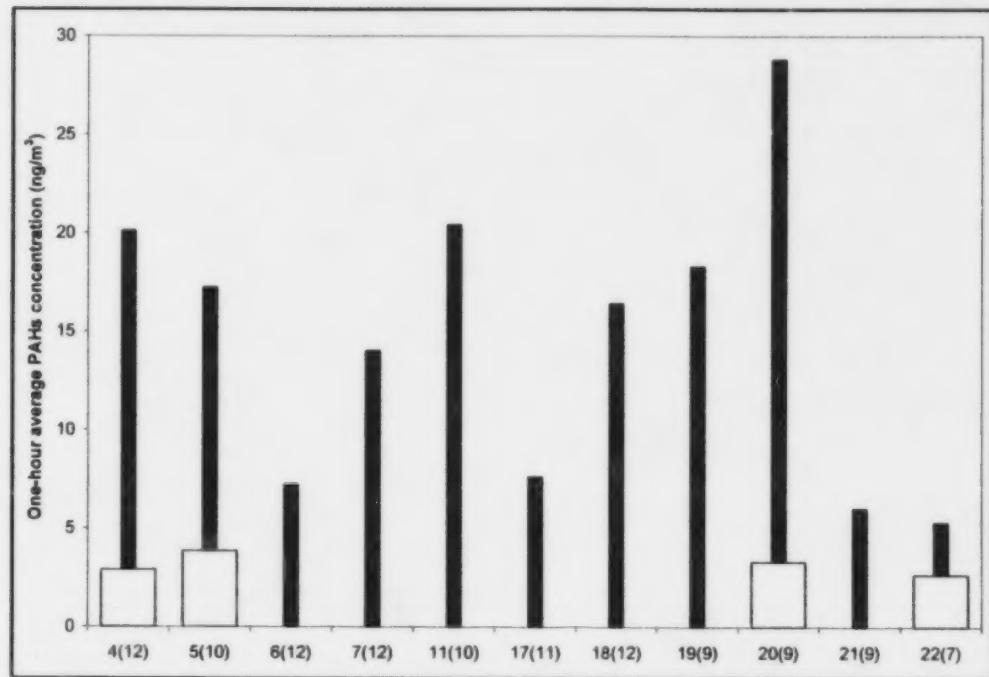


Figure 16: Median and maximum one-hour average concentrations for polycyclic aromatic hydrocarbons. The MAML monitors particulate bound PAHs only.

3.10 Volatile Organic Compounds (VOCs)

Vegetation, fossil fuel combustion, fugitive gasoline emissions, petroleum and chemical industries, dry cleaning and fireplaces are major sources of VOCs. Levels of reactive hydrocarbons (RHC) measured by the MAML downwind have already been discussed in section 3.1. For the most part concentrations were below the detection limit of the instrument on board the MAML. Samples of air were collected at selected sites for laboratory analysis. The samples were tested for levels of over 185 different VOC species. The full result of this analysis is presented in Appendix A (Table A3). A summary of the one-hour average concentrations are presented in Table 2. This table lists VOCs that were found to be above 1 $\mu\text{g}/\text{m}^3$ for at least one of the monitoring sites. Also listed in Table 2 are AAAQO, where objective exists.

Canister samples of air were collected at four sites: Site 20, 18 and two background sites. Site 20, 18 and one of the background site (Site 17) are described in Section 2. The second background site was located about 2 km north east of Site 18 (Boysdale Rd). The sample at this site was collected when the wind was from the northwest, thus upwind of Site 18 and the Canola oil plant Bunge Canada.

Concentrations determined from samples taken during the current study did not exceed existing air quality objectives. Vinylchloride concentration was found to be elevated relative to background levels for one of the samples collected at Site 20 (Oxyvinyls). This sample was collected prior to the shutdown of Oxyvinyls in March 2006. A sample collected in May 2006 had concentration comparable to background levels. Methanol, propane, butane and acetone had the highest concentrations for samples collected at Site 18. However concentrations for these VOCs were not that different from concentrations determined for the background samples. Acetaldehyde concentrations measured at one of the background sample sites were the highest measured (Table 2). The one-hour average concentration of 24.25 $\mu\text{g}/\text{m}^3$ measured was 27% of Alberta's ambient air quality guideline. One-hour average concentrations for pollutants monitored by the MAML at the time of the background canister sample indicate background air. For example one-hour average total hydrocarbons was 1.9 ppm, both SO₂ and reduced sulphur compounds were below detection limit, total suspended particles concentration was 4 $\mu\text{g}/\text{m}^3$ and NO_x concentration was 0.006 ppm.

Table 2: One-hour average concentrations for the most abundant⁷ VOCs.

Location	Canola Oil Plant			Oxyvinyle		Background		AAQO
	18-Jan-06	22-Dec-06	15-Mar-07	18-Feb-06	30-May-06	18-Jan-06	16-Mar-07	
Sample Date	18	18	18	20	20	8g	17	1-hour
Site #								
Concentration	µg/m ³							
2-Methylbutane	3.52	2.38	2.67	0.37	0.44	2.07	4.11	-
2-Methylpentane	1.78	0.56	1.49	0.12	0.12	0.59	1.13	-
3-Methylpentane	1.46	0.38	2.28	0.07	0.08	0.42	0.00	-
Acetaldehyde	2.65	3.71	3.40	ND	ND	24.25	4.04	90
Acetone	5.81	4.00	3.45	ND	ND	3.05	2.64	5900
Acetonitrile	0.26	0.28	0.08	ND	ND	1.08	0.11	-
Acrolein (2-Propenal)	0.32	0.47	0.36	ND	ND	2.00	0.34	-
Benzene	0.95	0.69	0.68	0.48	0.13	0.78	1.06	30
Butane	7.37	6.29	6.56	0.85	1.14	4.03	8.24	-
Butyraldehyde (Butanal)	0.59	0.60	0.30	ND	ND	1.05	0.23	-
Chloromethane	1.08	1.05	1.09	1.18	1.08	0.98	1.03	-
Cyclohexane	1.04	0.20	0.31	0.03	0.05	0.29	0.33	-
Dichloromethane	1.64	0.17	0.24	0.13	0.13	0.15	0.29	-
Ethanol	2.33	1.72	1.48	ND	ND	0.50	4.22	-
Freon 11 (Trichlorofluoromethane)	1.45	1.29	1.43	1.37	1.31	1.44	1.43	-
Freon 12 (Dichlorodifluoromethane)	2.69	2.62	2.34	2.59	2.45	2.89	2.33	-
Hexanal	0.83	1.01	0.49	ND	ND	0.46	0.31	-
Hexane	2.78	0.86	4.78	0.12	0.15	0.57	0.94	-
Iso butane (2-Methylpropane)	4.15	3.09	2.81	0.46	0.51	2.08	4.45	-
Iso propyl Alcohol	2.17	0.25	0.34	ND	ND	0.20	0.33	7850
m,p-Xylene	0.61	0.33	0.28	0.02	0.06	0.12	1.34	2300
MEK	0.72	0.43	1.04	ND	ND	0.58	1.12	-
Methanol	19.65	6.93	7.86	ND	ND	4.83	11.61	2600
Methylcyclopentane	0.75	0.34	1.18	0.05	0.07	0.33	0.63	-
p-Cymene (1-Methyl-4-Iso propylbenzene)	1.06	0.10	0.01	0.00	0.01	0.02	0.02	-
Pentane	2.16	1.97	2.63	0.30	0.39	1.90	2.59	-
Propane	8.48	11.28	13.48	1.79	2.48	7.69	12.14	-
Propionaldehyde	1.02	1.33	1.15	ND	ND	3.14	0.76	-
Toluene	2.54	0.68	0.66	0.18	0.12	0.38	1.50	1880
Vinylchloride (Chloroethene)	0.00	0.01	0.00	2.46	0.01	0.00	0.00	130

Notes:

bd - below detection limit ND - no data µg/m³ = micrograms per cubic meter

⁷ VOCs concentration was greater than 1 µg/m³ for at least one of the monitoring sites.

Appendix A

Table A1: Median one-hour average concentrations measured at selected MAML surveys and permanent monitoring stations.

Station or Survey Type	Air Quality Station or Survey Name	Monitoring Period	CO ppm	O ₃ ppm	THC ppm	CH ₄ ppm	RHC ppm	SO ₂ ppm	NO ₂ ppm	NH ₃ ppm	TRS ppm	H ₂ S ppm	TSP $\mu\text{g}/\text{m}^3$	PM ₁₀ $\mu\text{g}/\text{m}^3$	PM _{2.5} $\mu\text{g}/\text{m}^3$	PM ₁ $\mu\text{g}/\text{m}^3$	PAH ng/m ³
mobile	Fort Saskatchewan and Redwater Area (current)	Jan 2006 - Nov 2007	0.2	0.030	1.9	1.9	bd	0.003	0.004	0.003	bd	bd	17*	10	3	7*	bd
	Fort Saskatchewan and Redwater Area	May 2001 - Mar 2002	0.3	0.029	2.1	2.1	0.1	0.001	0.004	0.001	bd	bd	39	22	3	ND	bd
	Slave Lake	Dec 2005 - Mar 2006	0.2	0.003	2.4	2.4	bd	0.001	0.012	bd	0.001	bd	18	13	5	n/a	8
	Calder Yards Edmonton	Mar 2005	0.7	0.010	2.7	2.5	0.3	0.002	0.033	0.008	0.001	0.001	43	28	4	n/a	20
	Tolko High Prairie	Dec 2005 - Mar 2006	0.2	0.018	2.0	1.9	bd	0.001	0.005	bd	0.001	bd	18	12	3	n/a	bd
	Caroline	Oct 05 & Jan, May, Jun 06	0.2	0.038	1.8	1.8	bd	0.002	0.004	0.003	0.001	0.001	79	49	6	n/a	bd
	Girouxville	Fall 2004, spring 2005, 2006	0.3	0.028	2.1	2.1	bd	0.001	0.001	0.013	0.002	0.001	21	15	2	n/a	bd
	Whitecourt	Sep. 6 - 7, 2005	0.2	0.027	2.1	2.1	bd	0.001	0.002	0.084	0.001	0.001	28	16	2	n/a	bd
Permanent Continuous Monitoring Stations																	
urban	Calgary Central	Dec 05 - Mar 06	0.3	0.015	2.0	n/a	bd	n/a	0.021	n/a	n/a	n/a	n/a	20	5	n/a	n/a
	Edmonton Central	Dec 05 - Mar 06	0.3	0.016	2.0	n/a	n/a	n/a	0.018	n/a	n/a	n/a	n/a	n/a	4	n/a	n/a
semi-urban	Lethbridge	Dec 05 - Mar 06	0.2	0.031	2.0	2	n/a	bd	0.004	0.004	n/a	bd	n/a	n/a	3	n/a	n/a
	Fort Saskatchewan	Dec 05 - Mar 06	0.2	0.022	2.0	n/a	n/a	0.001	0.007	bd	n/a	bd	n/a	n/a	3	n/a	n/a
Industrial	Edmonton East	Dec 05 - Mar 06	0.2	0.022	2.1	n/a	n/a	0.001	0.012	n/a	n/a	bd	n/a	n/a	4	n/a	n/a
	Mildred Lake	Dec 05 - Mar 06	n/a	n/a	2.0	n/a	n/a	0.001	n/a	n/a	n/a	bd	n/a	n/a	n/a	n/a	n/a

Notes:

bd - below detection limit ND - no data * monitored for part of the study

ppm - parts per million ng/m³ = nanograms per cubic meter $\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

Table A2: One-hour average concentrations for each site as monitored by instruments onboard the MAML.

Site		Date	Sample Times	CO PPM	O ₃ PPM	THC PPM	CH ₄ PPM	RHC PPM	SO ₂ PPM	NO PPM	NO ₂ PPM	NO _x PPM	NH ₃ PPM	TRS PPM	H ₂ S PPM	TSP µg/m ³	PM ₁₀ µg/m ³	PM _{2.5} µg/m ³	PM ₁ µg/m ³	PAH ng/m ³
4	Dow and Shemitt	1/18/2006	10:36 to 11:37	0.1	0.019	2.0	2.0	bd	bd	0.004	0.007	0.011	0.004	bd	bd	4	3	1	ND	1
		2/9/2006	09:45 to 10:45	0.2	0.010	2.3	2.3	bd	0.003	0.105	0.039	0.144	0.953	0.005	0.002	36	23	3	ND	2
		5/16/2006	08:55 to 09:58	0.2	0.052	2.4	1.9	0.4	0.004	0.003	0.004	0.004	0.010	0.002	bd	29	17	3	ND	1
		6/21/2006	07:55 to 08:52	0.2	0.027	2.1	1.8	0.2	0.001	bd	bd	bd	0.003	bd	bd	ND	ND	ND	ND	1
		12/20/2006	10:11 to 11:14	1.1	0.009	ND	ND	ND	0.003	0.066	0.026	0.091	0.001	0.002	0.001	28	19	4	ND	9
		1/16/2007	09:45 to 10:47	0.8	0.008	2.3	2.3	bd	0.001	0.071	0.040	0.112	0.023	bd	bd	11	8	2	ND	20
		3/15/2007	08:59 to 10:01	0.5	0.015	2.4	2.3	0.1	0.004	0.041	0.026	0.066	0.039	bd	0.001	65	46	8	ND	7
		4/13/2007	08:14 to 09:15	0.5	0.008	2.4	2.4	0.1	0.003	0.100	0.046	0.146	0.091	bd	0.001	185	126	16	ND	14
		6/21/2007	12:54 to 14:04	0.2	0.045	1.9	1.9	bd	0.008	0.002	0.006	0.008	0.011	bd	bd	ND	23	12	10	2
		7/31/2007	08:18 to 09:17	0.1	0.022	1.8	1.8	bd	0.002	0.003	0.007	0.011	0.004	bd	bd	ND	bd	bd	bd	2
5	Shell Scotford	8/16/2007	10:40 to 11:47	0.2	0.024	1.7	1.6	bd	0.011	0.003	0.004	0.007	0.002	bd	bd	ND	16	10	9	4
		10/17/2007	11:30 to 12:31	0.1	0.026	1.9	1.9	bd	0.002	0.006	0.011	0.016	0.008	0.001	bd	ND	31	10	8	7
		1/27/2006	11:44 to 12:44	0.2	0.018	1.8	1.9	bd	0.002	0.004	0.006	0.011	bd	0.001	bd	26	11	3	ND	1
		2/16/2006	12:07 to 13:07	0.2	0.034	1.9	2.0	bd	0.004	0.001	0.002	0.001	bd	0.001	bd	17	10	3	ND	bd
		5/30/2006	07:19 to 08:17	0.1	0.023	1.8	1.8	bd	0.004	0.010	0.010	0.018	0.004	bd	bd	26	16	2	ND	5
		12/22/2006	09:56 to 10:55	0.4	0.018	2.1	2.1	bd	0.015	0.017	0.023	0.041	0.002	bd	0.001	8	6	2	ND	6
		1/18/2007	15:22 to 16:23	0.8	0.015	3.1	3.0	0.1	0.013	0.023	0.026	0.044	0.001	0.001	0.001	98	54	7	ND	8
		4/12/2007	08:18 to 09:19	0.2	0.017	2.2	2.2	bd	0.001	0.027	0.022	0.050	0.004	bd	bd	138	83	10	ND	17
		4/26/2007	11:27 to 12:28	0.2	0.049	1.9	1.9	bd	0.004	0.006	0.004	0.008	bd	bd	bd	27	16	2	ND	5
		7/10/2007	10:37 to 11:37	0.2	0.031	1.9	1.9	bd	0.007	0.001	0.002	0.002	0.004	bd	bd	ND	18	9	7	2
		8/17/2007	11:57 to 12:59	0.3	0.027	1.7	1.7	bd	0.025	0.006	0.008	0.013	bd	bd	bd	ND	23	9	6	3
		11/26/2007	10:21 to 11:22	0.2	0.033	2.0	2.0	0.1	0.006	0.001	0.005	0.005	bd	0.001	bd	ND	6	5	5	3

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Table A2: One-hour average concentrations continued from previous page

Site		Date	Sample Times	CO PPM	O ₃ PPM	THC PPM	CH ₄ PPM	RHC PPM	SO ₂ PPM	NO PPM	NO ₂ PPM	NO _x PPM	NH ₃ PPM	TRS PPM	H ₂ S PPM	TSP µg/m ³	PM ₁₀ µg/m ³	PM _{2.5} µg/m ³	PM ₁ µg/m ³	PAH ng/m ³
6	Agrium Redwater	1/18/2006	14:04 to 15:04	0.1	0.017	1.9	1.9	bd	0.001	0.002	0.004	0.006	0.014	bd	bd	11	7	1	ND	1
		2/9/2006	12:35 to 13:35	0.2	0.028	2.0	2.0	bd	0.002	0.010	0.012	0.022	0.072	0.001	bd	13	8	2	ND	bd
		5/16/2006	13:21 to 14:28	0.2	0.053	1.9	1.9	bd	0.006	0.009	0.013	0.019	0.050	0.002	0.001	88	53	7	ND	7
		6/21/2006	09:36 to 10:36	0.1	0.030	1.7	1.7	bd	bd	bd	0.001	0.002	0.001	bd	bd	ND	ND	ND	ND	bd
		12/20/2006	13:03 to 14:06	0.7	0.011	ND	ND	ND	0.004	0.033	0.024	0.056	0.011	0.002	0.001	36	25	4	ND	7
		1/16/2007	13:39 to 14:41	0.4	0.029	2.0	2.0	bd	0.003	0.007	0.013	0.020	0.003	bd	bd	13	10	2	ND	1
		3/15/2007	13:41 to 14:42	0.3	0.040	2.1	2.1	bd	0.009	0.007	0.008	0.013	0.006	bd	bd	46	31	6	ND	2
		4/13/2007	12:04 to 13:05	0.1	0.049	2.0	1.9	bd	0.002	bd	0.002	0.004	0.008	bd	bd	6	4	1	ND	1
		6/21/2007	10:05 to 11:07	0.1	0.034	2.0	2.0	bd	0.004	0.002	0.004	0.008	0.003	bd	bd	ND	21	13	11	4
		7/31/2007	14:03 to 15:08	0.2	0.031	1.7	1.7	bd	0.002	0.002	0.001	0.003	0.004	bd	bd	ND	bd	bd	bd	1
7	Town of Redwater	8/18/2007	13:04 to 14:04	0.2	0.032	1.7	1.6	bd	0.001	0.010	0.002	0.008	0.003	bd	bd	ND	13	4	3	5
		10/17/2007	09:53 to 11:01	0.1	0.016	2.1	2.1	bd	0.013	0.004	0.006	0.012	0.018	0.001	0.001	ND	49	16	9	5
		1/18/2006	15:33 to 16:33	0.2	0.020	1.9	1.9	bd	0.001	0.003	0.004	0.006	0.005	0.001	bd	3	3	1	ND	2
		2/9/2006	14:06 to 15:06	0.1	0.039	1.8	1.9	bd	0.001	0.002	0.001	0.003	0.009	bd	bd	2	1	bd	ND	bd
		5/16/2006	12:06 to 13:10	0.3	0.058	1.9	1.9	bd	0.004	0.003	0.005	0.006	0.006	0.002	bd	113	62	6	ND	1
		6/21/2006	11:02 to 12:12	0.1	0.034	1.7	1.7	bd	0.001	0.001	bd	0.001	bd	0.001	bd	16	11	2	ND	bd
		12/20/2006	14:23 to 15:23	0.8	0.008	ND	ND	ND	0.006	0.047	0.033	0.079	0.007	0.002	0.001	30	21	4	ND	14
		1/16/2007	14:54 to 15:57	0.3	0.039	2.0	2.0	bd	0.003	0.006	0.007	0.013	0.001	bd	bd	2	1	bd	ND	2
		3/15/2007	12:13 to 13:14	0.3	0.040	2.1	2.1	bd	0.003	0.003	0.005	0.006	0.003	bd	bd	14	10	2	ND	1
		4/13/2007	13:19 to 14:20	0.2	0.050	1.9	1.9	bd	0.002	0.001	0.004	0.006	0.005	bd	bd	47	30	4	ND	2
		6/21/2007	11:18 to 12:18	0.1	0.039	2.0	2.0	bd	0.008	0.001	0.003	0.004	0.005	bd	bd	ND	25	14	12	2
		7/31/2007	11:14 to 12:17	0.1	0.032	1.7	1.7	bd	0.004	0.001	0.002	0.003	0.008	bd	bd	ND	bd	bd	3	
		8/19/2007	14:36 to 15:37	0.2	0.038	1.9	1.6	0.2	0.002	0.001	0.002	0.003	bd	bd	bd	ND	12	4	2	2
		10/17/2007	08:18 to 09:18	0.2	0.012	2.2	2.2	bd	0.002	0.007	0.006	0.013	bd	0.001	0.001	ND	26	17	10	3

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Table A2: One-hour average concentrations continued from previous page

Site	Date	Sample Times	CO	O ₃	THC	CH ₄	RHC	SO ₂	NO	NO ₂	NO _x	NH ₃	TRS	H ₂ S	TSP	PM ₁₀	PM _{2.5}	PM ₁	PAH	
			PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	μg/m ³	μg/m ³	μg/m ³	μg/m ³	ng/m ³	
11	Bruderheim Arena	1/27/2006	16:06 to 17:06	0.2	0.019	1.9	1.9	bd	bd	0.001	0.003	0.005	bd	bd	bd	11	9	6	ND	1
		2/16/2006	09:05 to 10:07	0.2	0.033	1.9	2.0	bd	0.002	0.001	0.001	bd	bd	bd	14	10	3	ND	2	
		5/30/2006	10:46 to 11:46	0.1	0.033	1.8	1.8	bd	0.001	bd	bd	bd	0.003	bd	bd	24	14	2	ND	bd
		12/22/2006	13:37 to 14:38	0.2	0.021	2.1	2.1	bd	0.005	0.027	0.022	0.046	0.001	bd	0.001	16	10	2	ND	20
		1/18/2007	09:52 to 10:49	0.4	0.014	2.1	2.1	bd	0.007	0.016	0.023	0.038	bd	bd	0.001	16	11	2	ND	5
		4/12/2007	11:54 to 12:54	0.3	0.047	2.0	2.0	bd	0.002	0.005	0.004	0.007	0.008	bd	bd	10	6	1	ND	2
		4/26/2007	08:38 to 09:39	0.2	0.038	2.0	1.9	bd	0.005	0.005	0.006	0.008	bd	0.001	bd	33	18	2	ND	2
		7/10/2007	12:57 to 13:58	0.3	0.035	1.9	1.9	bd	0.008	0.002	0.003	0.004	0.002	bd	bd	ND	ND	ND	ND	1
		8/14/2007	08:01 to 09:02	0.2	0.014	1.8	1.7	bd	0.013	0.010	0.008	0.018	bd	bd	bd	ND	21	13	12	3
		11/26/2007	13:00 to 14:04	0.2	0.034	2.0	2.0	bd	0.004	0.002	0.004	0.004	bd	0.001	bd	ND	6	5	5	2
17	Dow Centennial Fields	1/18/2006	09:16 to 10:17	0.3	0.009	2.7	2.7	bd	bd	0.019	0.019	0.038	0.005	0.001	0.001	15	11	2	ND	5
		2/9/2006	17:05 to 18:05	0.1	0.036	1.9	1.9	bd	0.001	bd	0.002	0.002	0.004	bd	bd	4	3	1	ND	bd
		5/16/2006	14:58 to 15:59	0.2	0.062	1.8	1.9	bd	0.004	0.003	0.005	0.004	0.012	0.002	bd	177	106	10	ND	bd
		6/21/2006	15:10 to 16:10	0.2	0.042	1.7	1.7	bd	0.002	bd	bd	bd	0.001	bd	11	7	1	ND	bd	
		12/20/2006	08:48 to 09:49	0.4	0.009	ND	ND	ND	0.004	0.011	0.023	0.033	bd	0.002	bd	19	14	3	ND	4
		1/16/2007	16:38 to 17:40	0.3	0.026	2.0	2.0	bd	0.003	0.005	0.018	0.023	0.002	bd	bd	10	8	1	ND	3
		3/15/2007	07:24 to 08:38	0.4	0.007	2.4	2.3	bd	0.001	0.029	0.022	0.050	bd	bd	0.001	95	74	12	ND	8
		4/13/2007	15:01 to 16:01	0.1	0.053	1.9	1.9	bd	0.001	bd	0.002	0.002	0.004	bd	bd	14	9	1	ND	1
		6/21/2007	14:17 to 15:19	0.2	0.043	1.9	1.9	bd	0.005	0.002	0.003	0.005	0.018	bd	bd	ND	24	10	7	2
		7/31/2007	15:45 to 16:47	0.2	0.027	1.8	1.8	bd	0.005	0.003	0.002	0.003	0.004	bd	bd	ND	bd	bd	bd	2
		10/17/2007	13:59 to 14:59	0.1	0.034	1.9	1.9	bd	bd	0.001	0.002	0.003	0.004	bd	bd	ND	20	9	7	1

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Table A2: One-hour average concentrations continued from previous page

Site	Date	Sample Times	CO	O ₃	THC	CH ₄	RHC	SO ₂	NO	NO ₂	NO _x	NH ₃	TRS	H ₂ S	TSP	PM ₁₀	PM _{2.5}	PM ₁	PAH	
			PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	µg/m ³	µg/m ³	µg/m ³	µg/m ³	ng/m ³	
18	Canola Plant	1/18/2006	12:34 to 13:33	0.1	0.019	1.9	1.9	bd	0.001	0.002	0.003	0.005	0.004	0.001	5	3	1	ND	bd	
		2/9/2006	11:07 to 12:07	0.1	0.038	1.8	1.9	bd	0.005	0.001	0.001	0.002	0.022	0.002	0.001	130	40	3	ND	1
		5/16/2006	10:29 to 11:30	0.2	0.056	1.8	1.9	bd	0.003	bd	0.003	0.001	0.006	0.002	bd	24	37	3	ND	1
		6/21/2006	14:00 to 14:57	0.2	0.039	1.7	1.7	bd	0.002	bd	bd	bd	bd	0.001	bd	10	8	1	ND	bd
		12/20/2006	11:31 to 12:35	0.7	0.010	ND	ND	ND	0.005	0.064	0.029	0.093	0.009	0.003	0.001	75	44	7	ND	16
		1/16/2007	11:04 to 12:05	0.8	0.010	2.3	2.2	0.1	0.003	0.068	0.034	0.103	0.017	0.001	0.001	18	12	3	ND	10
		3/15/2007	10:19 to 11:24	0.4	0.030	2.2	2.2	bd	0.004	0.011	0.010	0.019	0.010	hd	bd	52	29	4	ND	3
		4/13/2007	09:29 to 10:29	0.4	0.022	2.2	2.1	bd	0.006	0.021	0.026	0.047	0.013	0.001	0.002	109	78	11	ND	7
		6/21/2007	08:43 to 09:46	0.2	0.026	2.0	2.0	bd	0.002	0.002	0.001	0.005	0.001	bd	bd	ND	19	12	11	2
		7/31/2007	09:34 to 10:34	bd	0.028	1.7	1.7	bd	0.006	0.002	0.002	0.005	0.015	bd	0.001	ND	bd	bd	bd	2
18a	upwind	10/17/2007	12:49 to 13:49	0.1	0.030	1.9	1.9	bd	bd	0.002	0.003	0.005	0.004	bd	bd	ND	24	9	6	2
19	Future Site of BA Upgrader	1/18/2006	11:50 to 12:21	0.2	0.018	1.9	1.9	bd	bd	0.003	0.004	0.006	0.008	bd	bd	4	2	1	ND	1
		1/27/2006	13:09 to 14:09	0.2	0.021	1.8	1.9	bd	0.001	bd	0.003	0.003	bd	0.001	bd	8	4	2	ND	bd
		2/16/2006	14:17 to 15:17	0.1	0.035	2.0	2.0	bd	0.001	bd	0.001	bd	bd	bd	bd	10	7	3	ND	bd
		5/30/2006	09:38 to 10:36	0.1	0.032	1.8	1.8	bd	0.002	bd	0.001	bd	0.003	bd	bd	14	8	1	ND	1
		12/22/2006	12:20 to 13:23	0.4	0.030	2.1	2.1	bd	0.007	0.009	0.010	0.018	0.001	bd	bd	5	3	1	ND	2
		1/18/2007	14:11 to 15:12	0.4	0.017	2.1	2.1	bd	0.004	0.016	0.023	0.036	0.002	bd	0.001	101	57	6	ND	18
		4/12/2007	10:35 to 11:42	0.2	0.032	2.2	2.1	bd	0.007	0.011	0.016	0.029	0.015	bd	0.001	44	27	4	ND	4
		4/26/2007	13:44 to 14:48	0.3	0.054	2.0	2.0	bd	0.004	0.002	0.004	0.004	bd	bd	bd	18	9	1	ND	1
		7/10/2007	11:47 to 12:46	0.3	0.033	1.9	1.9	bd	0.004	bd	0.001	0.001	0.004	bd	bd	ND	8	5	5	1
		11/26/2007	11:40 to 12:46	0.2	0.036	2.2	2.1	0.1	0.003	0.001	0.003	0.002	bd	0.001	0.001	ND	6	5	5	1

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Table A2: One hour average concentrations continued from previous page

Site	Date	Sample Times	CO	O ₃	THC	CH ₄	RHC	SO ₂	NO	NO ₂	NO _x	NH ₃	TRS	H ₂ S	TSP	PM ₁₀	PM _{2.5}	PM ₁	PAH	
			PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	µg/m ³	µg/m ³	µg/m ³	ng/m ³	
20	Oxyvinyls	1/27/2006	10:21 to 11:21	0.2	0.020	1.8	1.8	bd	0.001	0.002	0.003	0.005	0.001	0.001	bd	7	5	3	ND	bd
		2/16/2006	13:09 to 14:09	0.1	0.034	2.0	2.0	bd	0.005	0.001	0.002	0.001	bd	0.001	bd	17	11	3	ND	bd
		5/30/2006	08:21 to 09:27	0.1	0.028	1.8	1.8	bd	0.002	0.003	0.002	0.003	0.006	bd	bd	15	10	2	ND	3
		12/22/2006	11:03 to 12:04	0.6	0.013	2.3	2.3	bd	0.007	0.049	0.033	0.082	0.002	bd	bd	26	18	4	ND	18
		1/18/2007	16:26 to 17:27	0.5	0.010	2.3	2.3	bd	0.004	0.009	0.031	0.039	bd	bd	0.001	30	22	4	ND	10
		4/12/2007	09:25 to 10:24	0.3	0.015	2.4	2.3	bd	0.009	0.041	0.029	0.071	0.025	bd	0.001	34	41	6	ND	29
		4/26/2007	12:32 to 13:33	0.2	0.051	2.0	1.9	bd	0.003	0.004	0.005	0.006	bd	bd	bd	31	20	2	ND	3
		7/10/2007	09:12 to 10:12	0.5	0.014	2.3	2.2	0.1	0.021	0.017	0.014	0.031	0.001	0.001	0.001	ND	87	24	14	17
		11/26/2007	09:06 to 10:06	0.1	0.033	2.2	2.2	bd	0.007	bd	0.003	0.002	bd	0.001	0.001	ND	6	5	5	2
21	Acclaim Battery	1/27/2006	14:39 to 15:39	0.2	0.021	1.8	1.9	bd	bd	0.005	0.002	0.003	bd	0.001	bd	4	3	2	ND	bd
		2/16/2006	10:27 to 11:26	0.3	0.034	2.0	2.0	bd	0.001	0.001	0.001	bd	bd	0.001	bd	18	11	4	ND	bd
		5/30/2006	12:07 to 13:11	0.1	0.036	1.8	1.8	bd	bd	bd	bd	bd	0.004	0.001	bd	10	7	1	ND	bd
		12/22/2006	15:25 to 16:26	0.2	0.024	2.0	2.0	bd	0.004	0.005	0.016	0.018	bd	bd	bd	12	8	2	ND	4
		1/18/2007	11:13 to 12:15	0.5	0.014	2.2	2.2	bd	0.006	0.038	0.027	0.065	bd	bd	0.001	18	14	3	ND	6
		4/12/2007	13:33 to 14:36	0.1	0.051	2.0	2.0	bd	0.001	0.001	0.001	0.003	0.005	bd	bd	7	4	1	ND	1
		4/26/2007	09:59 to 10:59	0.2	0.047	1.8	1.9	bd	0.003	0.019	0.003	0.003	bd	bd	bd	19	9	1	ND	1
		7/10/2007	14:19 to 15:20	0.3	0.034	1.9	1.9	bd	0.008	0.001	0.001	0.002	0.003	bd	bd	ND	ND	ND	ND	1
		11/26/2007	14:36 to 15:35	0.2	0.035	1.9	1.9	bd	0.003	0.002	0.004	0.003	bd	0.001	bd	ND	6	5	5	1

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Table A2: One-hour average concentrations continued from previous page

Site	Date	Sample Times	CO	O ₃	THC	CH ₄	RHC	SO ₂	NO	NO ₂	NO _x	NH ₃	TRS	H ₂ S	TSP	PM ₁₀	PM _{2.5}	PM ₁	PAH	
			PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	μg/m ³	μg/m ³	μg/m ³	ng/m ³		
22	Future site of NW upgrader	2/9/2006	15:32 to 16:32	0.1	0.040	1.8	1.9	bd	0.001	bd	0.001	bd	0.002	0.001	bd	1	1	bd	ND	bd
		2/16/2006	15:39 to 16:39	0.1	0.033	1.9	2.0	bd	0.001	0.002	0.003	0.003	0.001	bd	bd	57	35	5	ND	2
		6/21/2006	12:24 to 13:25	0.2	0.034	1.7	1.8	bd	0.001	0.001	0.001	0.003	0.001	bd	bd	10	7	1	ND	3
		1/16/2007	12:32 to 13:32	0.6	0.020	2.1	2.1	bd	0.002	0.028	0.019	0.046	0.004	bd	bd	14	10	2	ND	5
		1/18/2007	12:51 to 13:50	0.3	0.028	2.1	2.1	bd	0.003	0.009	0.009	0.018	0.001	bd	bd	20	14	3	ND	2
		4/13/2007	10:55 to 11:57	0.4	0.034	2.1	2.0	bd	0.005	0.011	0.017	0.029	0.013	bd	bd	59	38	6	ND	3
		4/26/2007	15:11 to 16:11	0.3	0.053	1.9	1.9	bd	0.007	0.003	0.005	0.006	bd	bd	bd	27	16	2	ND	1
		7/31/2007	12:37 to 13:47	0.1	0.029	1.7	1.7	bd	0.002	0.007	0.004	0.011	0.007	bd	bd	ND	bd	bd	bd	5

Notes:

bd - below detection limit ND - no data

ppm - parts per million ng/m³ = nanograms per cubic meter μg/m³ = micrograms per cubic meter

Table A3: Operator remarks and weather conditions based on measurements at monitoring location.

Site	Date	Start/End Times	Comments	Temp °C	RH %RH	WSP KPH	WDR DEG	
4	Dow and Sherritt	1/18/2006	10:36 to 11:37	downwind of Dow, odor evident	-0.8	85.0	16.3	239
		2/9/2006	09:45 to 10:45	brewery type odours	1.6	57.0	17.7	269
		5/16/2006	08:55 to 09:58	slight odour w train @ 9:04	25.6	23.2	7.2	114
		6/21/2006	07:55 to 08:52		18.5	57.3	13.8	294
		12/20/2006	10:11 to 11:14	odours evident	-6.4	75.2	2.4	213
		1/16/2007	09:45 to 10:47	downwind of Sherritt - no odours	-0.9	71.1	2.7	266
		3/15/2007	08:59 to 10:01	downwind of Sherritt no odour evident	-3.7	79.8	13.4	234
		4/13/2007	08:14 to 09:15	slight odours, stronger @8:54	10.1	43.1	7.7	198
		6/21/2007	12:54 to 14:04		26.2	46.1	11.9	267
		7/31/2007	08:18 to 09:17	downwind of Marsulex and Praxair	13.5	83.9	7.7	158
5	Shell Scotford	8/16/2007	10:40 to 11:47		20.7	48.3	14.3	264
		10/17/2007	11:30 to 12:31		ND	ND	15.1	27
		1/27/2006	11:44 to 12:44	no odours. 100% cloud cover with mist/fog	-9.5	100.7	15.1	38
		2/16/2006	12:07 to 13:07		-23.5	62.3	14.3	256
		5/30/2006	07:19 to 08:17	faint odours	16.9	61.7	12.3	297
		12/22/2006	09:58 to 10:55		-0.5	58.1	15.6	239
		1/18/2007	15:22 to 16:23		-4.2	60.1	5.7	257
		4/12/2007	08:18 to 09:19	very slight odour	6.7	55.6	5.2	260
		4/26/2007	11:27 to 12:28		16.6	25.8	11.1	271
		7/10/2007	10:37 to 11:37		22.4	52.2	10.8	228
		8/17/2007	11:57 to 12:59		21.3	38.1	20.0	262
		11/26/2007	10:21 to 11:22	downwind of Shell Scotford	-18.2	60.3	6.7	71

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Table A3: Operator remarks and weather conditions continued from previous page

Site	Date	Start/End Times	Comments	Temp °C	RH %RH	WSP KPH	WDR DEG	
6	Agrium Redwater	1/18/2006	14:04 to 15:04	downwind of Agrium	-4.9	73.2	8.2	259
		2/9/2006	12:35 to 13:35	downwind of Agrium	4.6	41.7	5.0	266
		5/16/2006	13:21 to 14:28	light odours	27.6	19.8	10.6	165
		6/21/2006	09:36 to 10:36		20.8	48.2	12.2	303
		12/20/2006	13:03 to 14:06	very slight odours	-2.4	58.2	2.0	139
		1/16/2007	13:39 to 14:41		0.7	67.0	2.7	ND
		3/15/2007	13:41 to 14:42	no odours	2.2	48.3	7.6	227
		4/13/2007	12:04 to 13:05		18.2	24.2	8.7	178
		6/21/2007	10:05 to 11:07		24.8	51.7	10.9	160
		7/31/2007	14:03 to 15:08		20.2	60.9	13.8	254
		8/18/2007	13:04 to 14:04		20.6	35.5	16.5	283
		10/17/2007	09:53 to 11:01		ND	ND	6.0	248
7	Town of Redwater	1/18/2006	15:33 to 16:33		-8.0	75.2	13.8	283
		2/9/2006	14:06 to 15:06	Lions Park in Redwater no odours	1.7	47.5	17.2	287
		5/16/2006	12:06 to 13:10		26.7	20.0	6.6	150
		6/21/2006	11:02 to 12:12		22.1	40.7	12.9	287
		12/20/2006	14:23 to 15:23		-0.9	56.0	2.9	152
		1/16/2007	14:54 to 15:57	no odours	1.9	56.4	2.1	ND
		3/15/2007	12:13 to 13:14		-0.8	57.6	10.2	254
		4/13/2007	13:19 to 14:20		15.9	25.0	15.7	182
		6/21/2007	11:18 to 12:18		25.9	50.2	9.0	162
		7/31/2007	11:14 to 12:17		21.3	48.5	7.2	249
		8/19/2007	14:36 to 15:37		22.4	28.2	22.0	307
		10/17/2007	08:18 to 09:18		ND	ND	5.8	291

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Table A3: Operator remarks and weather conditions continued from previous page

Site	Date	Start/End Times	Comments	Temp °C	RH %RH	WSP KPH	WDR DEG
11 Bruderheim Arena	1/27/2006	16:06 to 17:06	No odours.	-10.3	99.6	n/a	North
	2/16/2006	09:05 to 10:07		-26.0	55.9	9.8	178
	5/30/2006	10:46 to 11:46		19.3	50.3	13.2	287
	12/22/2006	13:37 to 14:38	snow cleaning on street south of arena	-1.4	54.6	9.3	235
	1/18/2007	09:52 to 10:49	no odours	-7.9	69.7	8.2	224
	4/12/2007	11:54 to 12:54	no odours	12.6	29.8	5.5	175
	4/26/2007	08:38 to 09:39	no odours	13.5	33.4	6.9	273
	7/10/2007	12:57 to 13:58		23.2	45.8	8.0	263
	8/14/2007	08:01 to 09:02		19.5	54.0	7.3	214
	11/26/2007	13:00 to 14:04		-18.0	65.9	9.8	116
17 Dow Centennial Fields	1/18/2006	09:16 to 10:17		-1.8	80.9	7.5	226
	2/9/2006	17:05 to 18:05		-0.8	55.5	18.1	323
	5/16/2006	14:58 to 15:59		30.8	18.4	8.2	182
	6/21/2006	15:10 to 16:10		24.9	29.3	19.1	299
	12/20/2006	08:48 to 09:49		-12.1	93.2	1.8	126
	1/16/2007	16:38 to 17:40	no odours	0.4	59.4	2.3	ND
	3/15/2007	07:24 to 08:38	very light wind, misty	-9.9	91.3	2.8	126
	4/13/2007	15:01 to 16:01		15.1	26.9	23.4	185
	6/21/2007	14:17 to 15:19		25.8	43.9	18.5	218
	7/31/2007	15:45 to 16:47		16.8	70.8	6.0	173
	10/17/2007	13:59 to 14:59		ND	ND	14.9	308

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Table A3: Operator remarks and weather conditions continued from previous page

Site		Date	Start/End Times	Comments	Temp °C	RH %RH	WSP KPH	WDR DEG
18	Canola Plant	1/18/2006	12:34 to 13:33	downwind of Sime Farms	-3.2	72.3	17.2	224
		2/9/2006	11:07 to 12:07		1.5	52.2	36.4	320
		5/16/2006	10:29 to 11:30	no odours	26.9	18.3	11.2	137
		6/21/2006	14:00 to 14:57	some slight intermittent odours	22.9	35.0	19.7	291
		12/20/2006	11:31 to 12:35	odours evident	-1.7	59.8	4.9	239
		1/16/2007	11:04 to 12:05	slight odours	-1.3	74.7	3.0	340
		3/15/2007	10:19 to 11:24	odours evident	-3.4	73.8	11.3	230
		4/13/2007	09:29 to 10:29	odours fairly strong	11.0	39.5	11.7	206
		6/21/2007	08:43 to 09:45		19.9	69.6	17.1	139
		7/31/2007	09:34 to 10:34		17.4	65.0	5.5	89
		10/17/2007	12:49 to 13:49	slight odours	ND	ND	15.6	274
18a	upwind of Canola plant	1/18/2006	11:50 to 12:21		-1.8	79.5	17.8	303
19	Future Site of BA Upgrader	1/27/2006	13:09 to 14:08	100% cloud cover with mist/fog	-10.3	100.0	18.1	59
		2/16/2006	14:17 to 15:17	earth moving construction	-21.4	45.6	10.4	129
		5/30/2006	09:38 to 10:36		17.9	56.7	17.4	288
		12/22/2006	12:20 to 13:23	no odours	-0.5	49.9	12.0	249
		1/18/2007	14:11 to 15:12		-6.4	57.9	5.5	274
		4/12/2007	10:35 to 11:42	no odours	12.1	36.3	5.7	193
		4/26/2007	13:44 to 14:48	no odours	19.8	19.4	12.9	240
		7/10/2007	11:47 to 12:46		22.2	48.0	11.8	252
		11/28/2007	11:40 to 12:46		-18.8	62.6	8.3	127

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Table A3: Operator remarks and weather conditions continued from previous page

Site		Date	Start/End Times	Comments	Temp °C	RH %RH	WSP KPH	WDR DEG
20	Oxyvinyls	1/27/2006	10:21 to 11:21	100% cloud cover with mist/fog	-9.2	101.2	14.6	65
		2/16/2006	13:09 to 14:09	very slight odour	-21.8	49.7	9.7	207
		5/30/2006	08:21 to 09:27	at gate on Rge Rd 214	17.2	61.0	9.9	273
		12/22/2006	11:03 to 12:04	no odours	-2.3	61.4	12.8	197
		1/18/2007	16:26 to 17:27		-9.4	74.0	8.0	220
		4/12/2007	09:25 to 10:24	oil type odour is evident.	8.7	53.5	7.3	182
		4/26/2007	12:32 to 13:33		16.8	23.5	12.1	256
		7/10/2007	09:12 to 10:12	downwind of plant	20.7	63.3	4.9	137
		11/26/2007	09:06 to 10:06	downwind of old Oxyvinyls plant	-18.4	66.6	7.9	65
21	Acciaim Battery	1/27/2006	14:39 to 15:39	100% cloud cover with mist/fog no odours	-10.7	99.3	ND	ND
		2/16/2006	10:27 to 11:26	very faint odour	-25.0	52.3	16.8	89
		5/30/2006	12:07 to 13:11	thundershower	17.2	53.3	30.4	301
		12/22/2006	15:25 to 16:26	no odours	-5.3	67.1	10.3	254
		1/18/2007	11:13 to 12:15	no odours	-7.8	71.8	9.5	248
		4/12/2007	13:33 to 14:36	no odours	14.0	29.3	7.7	90
		4/26/2007	09:59 to 10:59	move a bit south	17.9	25.0	8.8	263
		7/10/2007	14:19 to 15:20		23.1	50.0	7.2	272
		11/26/2007	14:36 to 15:35		-18.3	70.1	12.3	169

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Table A3: Operator remarks and weather conditions continued from previous page

Site		Date	Start/End Times	Comments	Temp °C	RH %RH	WSP KPH	WDR DEG
22	Future site of NW upgrader	2/9/2006	15:32 to 16:32	Lots of ground moving equipment activity.	1.0	49.2	25.7	294
		2/16/2006	15:39 to 16:39	earth moving construction	-20.5	43.2	14.0	285
		6/21/2006	12:24 to 13:25		22.4	38.2	20.7	292
		1/18/2007	12:32 to 13:32	no odours	-2.2	75.1	3.2	ND
		1/18/2007	12:51 to 13:50		-7.3	63.0	12.3	217
		4/13/2007	10:55 to 11:57		13.9	35.7	13.7	214
		4/26/2007	15:11 to 16:11	some odour from nearby facility	19.3	19.6	13.1	272
		7/31/2007	12:37 to 13:47		19.2	53.5	13.0	289

Notes:

Temp - Temperature in degrees centigrade **RH** - Relative humidity in percentage **WSP KPH** - Wind speed in Km/hr
WDR DEG - Wind direction in degrees

Table A4: One-hour average VOCs concentrations

Location	Canola Oil Plant			Oxyvinyls		Background	
Sample Date	18-Jan-06	22-Dec-06	15-Mar-07	16-Feb-06	30-May-06	18-Jan-06	15-Mar-07
Site #	18	18	18	20	20	Bg	17
Concentration	µg/m ³						
1,1,1-Trichloroethane	0.10	0.06	0.07	0.08	0.07	0.09	0.07
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2,3-Trimethylbenzene	0.09	0.03	0.01	0.00	0.01	0.01	0.07
1,2,4-Trichlorobenzene	0.01	0.04	0.00	0.01	0.00	0.01	0.00
1,2,4-Trimethylbenzene	0.18	0.10	0.04	0.00	0.03	0.03	0.25
1,2-Dibromoethane (EDB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichlorobenzene	0.00	0.01	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethane	0.06	0.36	0.05	0.03	0.03	0.05	0.05
1,2-Dichloropropane	0.01	0.02	0.01	0.01	0.01	0.01	0.02
1,2-Diethylbenzene	0.00	0.01	0.00	0.00	0.00	0.00	0.00
1,3,5-Trimethylbenzene	0.04	0.03	0.01	0.00	0.01	0.01	0.06
1,3-Butadiene	0.04	0.04	0.01	0.00	0.01	0.03	0.08
1,3-Dichlorobenzene	0.00	0.01	0.00	0.00	0.00	0.00	0.00
1,3-Diethylbenzene	0.01	0.01	0.00	0.00	0.00	0.00	0.01
1,4-Dichlorobenzene	0.03	0.01	0.01	0.00	0.00	0.01	0.02
1,4-Dichlorobutane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,4-Diethylbenzene	0.00	0.03	0.01	0.00	0.01	0.00	0.05
1-Butanol (Butyl alcohol)	0.24	0.20	0.15	ND	ND	0.13	0.42
1-Butene/2-Methylpropene	0.56	0.19	0.07	0.15	0.32	0.25	0.25
1-Butyne	0.00	0.00	0.00	0.00	0.00	0.01	0.00
1-Decene	0.00	0.01	0.00	0.00	0.03	0.00	0.00
1-Heptene	0.23	0.00	0.00	0.02	0.00	0.12	0.00
1-Hexene/2-Methyl-1-Pentene	0.04	0.03	0.00	0.01	0.09	0.02	0.00
1-Methylcyclohexene	0.00	0.00	0.00	0.00	0.00	0.00	0.01
1-Methylcyclopentene	0.01	0.00	0.01	0.00	0.00	0.00	0.01
1-Nonene	0.07	0.03	0.01	0.01	0.05	0.03	0.00
1-Octene	0.05	0.04	0.02	0.00	0.06	0.00	0.02
1-Pentene	0.05	0.03	0.02	0.03	0.11	0.00	0.06
1-Undecene	0.00	0.02	0.00	0.00	0.04	0.00	0.01
2,2,3-Trimethylbutane	0.01	0.00	0.01	0.00	0.00	0.01	0.02
2,2,4-Trimethylpentane	0.19	0.17	0.14	0.01	0.04	0.04	0.47
2,2,5-Trimethylhexane	0.01	0.02	0.01	0.00	0.00	0.00	0.02
2,2-Dimethylbutane	0.17	0.05	0.07	0.03	0.01	0.07	0.08
2,2-Dimethylhexane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,2-Dimethylpentane	0.04	0.02	0.02	0.00	0.00	0.02	0.04
2,2-Dimethylpropane	0.04	0.03	0.03	0.02	0.01	0.03	0.05
2,3,4-Trimethylpentane	0.05	0.06	0.03	0.00	0.01	0.01	0.11
2,3-Dimethylbutane	0.32	0.12	0.21	0.02	0.02	0.11	0.25
2,3-Dimethylpentane	0.25	0.16	0.13	0.02	0.04	0.10	0.35
2,4-Dimethylhexane	0.06	0.03	0.03	0.00	0.01	0.03	0.07
2,4-Dimethylpentane	0.10	0.07	0.07	0.01	0.01	0.04	0.17
2,5-Dimethylhexane	0.04	0.02	0.02	0.00	0.00	0.02	0.05
2-Butanol	0.03	0.02	0.05	ND	ND	0.01	0.14
2-Butenal (Crotonaldehyde)	0.00	0.00	0.00	ND	ND	0.00	0.00
2-Ethyl-1-Butene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-Ethyltoluene	0.05	0.03	0.02	0.00	0.01	0.01	0.07
2-Methyl-1-Butene	0.06	0.04	0.01	0.00	0.02	0.02	0.08
2-Methyl-2-Butene	0.07	0.02	0.01	0.00	0.01	0.01	0.07
2-Methylbutanal(isovaleraldehyde)	0.11	0.14	0.10	ND	ND	0.09	0.12
2-Methylbutane	3.52	2.38	2.67	0.37	0.44	2.07	4.11
2-Methylfuran	0.02	0.03	0.00	ND	ND	0.02	0.00

Continued on the next page

Table A4: One-hour average VOCs concentrations continued from the previous page

Location	Canola Oil Plant			Oxyvinyls		Background	
	Sample Date	18-Jan-06	22-Dec-06	15-Mar-07	16-Feb-06	30-May-06	18-Jan-06
Site #	18	18	18	20	20	Bg	17
Concentration	µg/m ³						
2-Methylheptane	0.08	0.08	0.12	0.03	0.01	0.05	0.15
2-Methylhexane	0.28	0.18	0.20	0.04	0.03	0.11	0.35
2-Methylpentane	1.78	0.56	1.49	0.12	0.12	0.59	1.13
2-Methyl-Propanal (Isobutylaldehyde)	0.15	0.15	0.21	ND	ND	0.14	0.20
2-Pentanone	0.25	0.19	0.21	ND	ND	0.15	0.30
3,6-Dimethyloctane	0.02	0.00	0.00	0.00	0.00	0.00	0.01
3-Ethyltoluene	0.10	0.06	0.04	0.00	0.01	0.02	0.17
3-Methyl-1-Butene	0.02	0.01	0.01	0.00	0.01	0.01	0.03
3-Methyl-1-Pentene	0.01	0.00	0.00	0.00	0.00	0.00	0.01
3-Methylheptane	0.07	0.05	0.05	0.01	0.01	0.03	0.12
3-Methylhexane	0.36	0.19	0.23	0.04	0.04	0.15	0.40
3-Methylpentane	1.48	0.38	2.28	0.07	0.08	0.42	0.00
4-Ethyltoluene	0.06	0.03	0.02	0.00	0.01	0.01	0.08
4-Methyl-1-Pentene	0.00	0.00	0.00	0.00	0.01	0.00	0.01
4-Methylheptane	0.03	0.02	0.02	0.01	0.00	0.02	0.05
Acetaldehyde	2.65	3.71	3.40	ND	ND	24.25	4.04
Acetone	5.81	4.00	3.45	ND	ND	3.05	2.64
Acetonitrile	0.26	0.28	0.09	ND	ND	1.08	0.11
Acrolein (2-Propenal)	0.32	0.47	0.36	ND	ND	2.00	0.34
Acrylonitrile (2-Propennitrile)	0.16	0.00	0.00	ND	ND	0.61	0.00
a-Pinene	0.04	0.01	0.00	0.00	0.02	0.01	0.16
Benzaldehyde	0.21	0.11	0.16	ND	ND	0.37	0.20
Benzene	0.95	0.69	0.68	0.46	0.13	0.78	1.06
Benzyl Chloride	0.00	0.00	0.00	0.00	0.00	0.00	0.00
b-Pinene	0.02	0.00	0.01	0.00	0.04	0.02	0.04
Bromodichloromethane	0.00	0.00	0.02	0.00	0.00	0.00	0.03
Bromoform	0.01	0.01	0.01	0.02	0.00	0.01	0.01
Bromomethane	0.03	0.04	0.05	0.05	0.05	0.04	0.04
Bromotrichloromethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Butane	7.37	6.29	6.56	0.85	1.14	4.03	8.24
Butylacetate	0.04	0.00	0.11	ND	ND	0.01	0.08
Butyraldehyde (Butanal)	0.59	0.60	0.30	ND	ND	1.05	0.23
c-1,2-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c-1,2-Dimethylcyclohexane	0.01	0.00	0.01	0.00	0.01	0.01	0.02
c-1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c-1,3-Dimethylcyclohexane	0.07	0.04	0.04	0.01	0.01	0.06	0.09
c-1,4/t-1,3-Dimethylcyclohexane	0.02	0.01	0.01	0.00	0.00	0.02	0.03
c-2-Butene	0.05	0.01	0.00	0.00	0.01	0.01	0.04
c-2-Heptene	0.00	0.00	0.00	0.00	0.00	0.11	0.01
c-2-Hexene	0.01	0.00	0.00	0.00	0.00	0.00	0.01
c-2-Pentene	0.03	0.01	0.00	0.00	0.01	0.00	0.03
c-3-Heptene	0.00	0.00	0.00	0.00	0.01	0.00	0.00
c-3-Methyl-2-Pentene	0.02	0.01	0.01	0.00	0.00	0.00	0.01
c-4-Methyl-2-Pentene	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Camphene	0.05	0.07	0.01	0.00	0.03	0.07	0.02
Carbon Disulfide	0.53	0.14	0.10	ND	ND	0.11	0.11
Carbontetrachloride	0.51	0.44	0.44	0.50	0.43	0.25	0.43
Chlorobenzene	0.01	0.01	0.01	0.00	0.00	0.01	0.01
Chloroethane	0.02	0.02	0.01	0.04	0.03	0.01	0.01
Chloroform	0.07	0.06	0.06	0.05	0.05	0.06	0.07
Chloromethane	1.08	1.05	1.09	1.18	1.08	0.98	1.03
Cyclohexane	1.04	0.20	0.31	0.03	0.05	0.29	0.33

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Table A4: One-hour average VOCs concentrations continued from the previous page

Location	Canola Oil Plant				Oxyvinyls		Background	
	18-Jan-06	22-Dec-06	15-Mar-07	18-Feb-06	30-May-06	18-Jan-06	15-Mar-07	
Sample Date	18	18	18	20	20	Bg	17	
Site #								
Concentration	µg/m ³							
Cyclohexanone	0.00	0.00	0.04	ND	ND	0.08	0.05	
Cyclohexene	0.00	0.00	0.01	0.00	0.00	0.00	0.00	
Cyclopentane	0.20	0.15	0.21	0.03	0.04	0.14	0.25	
Cyclopentanone	0.00	0.00	0.03	ND	ND	0.05	0.00	
Cyclopentene	0.01	0.00	0.00	0.00	0.01	0.00	0.01	
Decane	0.19	0.04	0.05	0.00	0.02	0.02	0.11	
Dibromochloromethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Dibromomethane	0.02	0.02	0.02	0.02	0.02	0.03	0.02	
Dichloromethane	1.64	0.17	0.24	0.13	0.13	0.15	0.29	
Dodecane	0.00	0.05	0.04	0.00	0.05	0.00	0.06	
Ethanol	2.33	1.72	1.48	ND	ND	0.50	4.22	
Ethylacetate	0.13	0.23	0.04	ND	ND	0.00	0.21	
Ethylbenzene	0.24	0.25	0.14	0.02	0.02	0.06	0.42	
Ethylbromide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ethylene oxide	0.00	0.00	0.10	ND	ND	0.04	0.05	
Freon 11 (Trichlorofluoromethane)	1.45	1.29	1.43	1.37	1.31	1.44	1.43	
Freon 113 (1,1,2-Trichlorotrifluoroethane)	0.66	0.52	0.61	0.63	0.56	0.66	0.60	
Freon 114 (1,2-Dichlorotetrafluoroethane)	0.20	0.10	0.11	0.11	0.10	0.12	0.11	
Freon 12 (Dichlorodifluoromethane)	2.69	2.62	2.34	2.59	2.45	2.69	2.33	
Freon 22 (Chlorodifluoromethane)	0.75	0.56	0.56	0.59	0.54	0.54	0.57	
Heptane	0.31	0.23	0.29	0.08	0.06	0.19	0.43	
Hexachlorobutadiene	0.00	0.02	0.00	0.00	0.00	0.00	0.00	
Hexanal	0.83	1.01	0.49	ND	ND	0.46	0.31	
Hexane	2.78	0.66	4.78	0.12	0.15	0.57	0.94	
Hexylbenzene	0.00	0.05	0.00	0.00	0.00	0.00	0.00	
Indan (2,3-Dihydroindene)	0.02	0.02	0.01	0.00	0.00	0.01	0.03	
Isobutane (2-Methylpropane)	4.15	3.09	2.81	0.46	0.51	2.08	4.45	
Isobutylacetate	0.00	0.00	0.07	ND	ND	0.00	0.00	
Isobutylalcohol	0.00	0.00	0.00	ND	ND	0.00	0.00	
Iso-Butylbenzene	0.01	0.01	0.00	0.00	0.00	0.00	0.01	
Isoprene (2-Methyl-1,3-Butadiene)	0.03	0.08	0.00	0.00	0.12	0.01	0.04	
Isopropyl Alcohol	2.17	0.25	0.34	ND	ND	0.20	0.33	
Isopropylacetate	0.00	0.00	0.00	ND	ND	0.00	0.00	
Iso-Propylbenzene	0.03	0.01	0.01	0.00	0.00	0.01	0.02	
Limonene	0.12	0.03	0.00	0.00	0.01	0.01	0.06	
m,p-Xylene	0.61	0.33	0.28	0.02	0.08	0.12	1.34	
MAC (2-Methyl-2-propenal)	0.04	0.12	0.03	ND	ND	0.19	0.04	
MEK	0.72	0.43	1.04	ND	ND	0.59	1.12	
Methanol	19.65	6.93	7.86	ND	ND	4.83	11.61	
Methyl Acetate	0.15	0.08	0.07	ND	ND	0.07	0.07	
Methylcyclohexane	0.36	0.25	0.26	0.04	0.05	0.34	0.48	
Methylcyclopentane	0.75	0.34	1.18	0.05	0.07	0.33	0.63	
Methyl-t-Butyl Ether (MTBE)	0.00	0.00	0.01	0.00	0.00	0.00	0.02	
MIBK	0.04	0.00	0.04	ND	ND	0.01	0.06	
MVK	0.00	0.00	0.00	ND	ND	0.26	0.00	
Naphthalene	0.05	0.06	0.03	0.00	0.03	0.01	0.06	
n-Butylbenzene	0.01	0.01	0.01	0.00	0.00	0.00	0.02	
Nonane	0.10	0.05	0.06	0.01	0.02	0.03	0.14	
n-Propylbenzene	0.04	0.03	0.02	0.00	0.01	0.01	0.06	
Octane	0.11	0.09	0.11	0.04	0.03	0.06	0.16	
o-Xylene	0.24	0.12	0.12	0.01	0.03	0.05	0.49	
p-Cymene (1-Methyl-4-Isopropylbenzene)	1.06	0.10	0.01	0.00	0.01	0.02	0.02	
Pentanal	0.40	0.67	0.27	ND	ND	0.31	0.21	
Pentane	2.16	1.97	2.63	0.30	0.39	1.90	2.59	

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Table A4: One-hour average VOCs concentrations continued from the previous page

Location	Canola Oil Plant				Oxyvinyls	Background	
	18-Jan-06	22-Dec-06	15-Mar-07	16-Feb-08		18-Jan-06	15-Mar-07
Sample Date	18	18	18	20	20	Bg	17
Site #							
Concentration	µg/m ³						
<i>Propane</i>	8.48	11.26	13.48	1.79	2.48	7.69	12.14
<i>Propene</i>	0.35	0.42	0.13	0.11	0.22	0.25	0.58
<i>Propionaldehyde</i>	1.02	1.33	1.15	ND	ND	3.14	0.76
<i>Propyl alcohol (1-Propanol)</i>	0.14	0.12	0.11	ND	ND	0.08	0.02
<i>Propyne</i>	0.06	0.03	0.04	0.01	0.01	0.04	0.09
<i>sec-Butylbenzene</i>	0.01	0.01	0.00	0.00	0.00	0.00	0.01
<i>Styrene</i>	0.04	0.08	0.01	0.00	0.01	0.01	0.12
<i>t-1,2-Dichloroethene</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>t-1,2-Dimethylcyclohexane</i>	0.06	0.03	0.03	0.01	0.01	0.06	0.07
<i>t-1,3-Dichloropropene</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>t-1,4-Dimethylcyclohexane</i>	0.04	0.02	0.02	0.00	0.00	0.04	0.05
<i>t-2-Butene</i>	0.05	0.02	0.00	0.00	0.01	0.00	0.05
<i>t-2-Heptene</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>t-2-Hexene</i>	0.01	0.01	0.00	0.00	0.01	0.00	0.01
<i>t-2-Octene</i>	0.01	0.00	0.02	0.00	0.00	0.00	0.03
<i>t-2-Pentene</i>	0.06	0.01	0.00	0.00	0.01	0.00	0.05
<i>t-3-Heptene</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>t-3-Methyl-2-Pentene</i>	0.01	0.00	0.00	0.00	0.00	0.00	0.01
<i>t-4-Methyl-2-Pentene</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>tert-Butylbenzene</i>	0.00						
<i>Tetrachloroethene</i>	0.12	0.04	0.11	0.03	0.02	0.04	0.14
<i>Toluene</i>	2.54	0.69	0.66	0.18	0.12	0.39	1.50
<i>Trichloroethene</i>	0.08	0.02	0.04	0.01	0.01	0.02	0.04
<i>Undecane</i>	0.65	0.04	0.06	0.00	0.03	0.02	0.15
<i>Vinylchloride (Chloroethane)</i>	0.00	0.01	0.00	2.46	0.01	0.00	0.00

Notes:

Bold and Italics indicates concentrations above detection limit

ND - no data µg/m³ = micrograms per cubic meter

Appendix B

The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives¹ are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.

The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table B1. Additional objectives can be found on the Alberta Environment's web site or through the department's information centre ((780) 427-2700).

Table B1: Alberta's Ambient Air Quality Objective measured by the MAML

Pollutant	One-hour AAAQO (ppm*)	Basis for Objective
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function

ppm - parts per million

¹ Alberta Ambient Air Quality Objectives. Alberta Environment. April 2005.

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Sulphur dioxide	0.172	pulmonary function

ppm - parts per million

¹ Alberta Ambient Air Quality Objectives. Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table B2 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.



Figure B1: Alberta Environment's Mobile Air Monitoring Laboratory

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia (NH_3)	0.001 ppm	5 ppm
Ozone (O_3)	0.001 ppm	0.5 ppm
Carbon Monoxide (CO)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (CH_4)	0.1 ppm	20 ppm
Reactive Hydrocarbons (RHC)	0.1 ppm	20 ppm
Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m ³	1000 ng/m ³
Oxides of nitrogen		
Nitrogen dioxide (NO_2)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO_x)	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates (TSP)	1 $\mu\text{g}/\text{m}^3$	1.0 g/m ³
Particulate Matter $<10\mu\text{m}$ (PM_{10})	1 $\mu\text{g}/\text{m}^3$	1.0 g/m ³
Particulate Matter $<2.5\mu\text{m}$ ($\text{PM}_{2.5}$)	1 $\mu\text{g}/\text{m}^3$	1.0 g/m ³
Sulphur Compounds		
Hydrogen Sulphide (H_2S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO_2)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm = parts per million

ng/m³ = nanograms per cubic meter $\mu\text{g}/\text{m}^3$ = micrograms per cubic meterg/m³ = grams per cubic meter

* The **lower detection limit** indicates the minimum amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The **upper detection limit** indicates the maximum amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are measured) is then compromised.

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia (NH ₃)	0.001 ppm	5 ppm
Ozone (O ₃)	0.001 ppm	0.5 ppm
Carbon Monoxide (CO)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (CH ₄)	0.1 ppm	20 ppm
Reactive Hydrocarbons (RHC)	0.1 ppm	20 ppm
Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m ³	1000 ng/m ³
Oxides of nitrogen		
Nitrogen dioxide (NO ₂)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO _x)	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates (TSP)	1 µg/m ³	1.0 g/m ³
Particulate Matter <10µm (PM ₁₀)	1 µg/m ³	1.0 g/m ³
Particulate Matter <2.5µm (PM _{2.5})	1 µg/m ³	1.0 g/m ³
Sulphur Compounds		
Hydrogen Sulphide (H ₂ S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO ₂)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm - parts per million

ng/m³ = nanograms per cubic meter

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* The **lower detection limit** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

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